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RESEARCH PROGRESS REPORTS

Fruit and Vegetable Processing and Technology Division

DEPARTMENT OF HORTICULTURE
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EVALUATION OF SNAP BEAN VARIETIES FOR PROCESSING

by

Wilbur A. Gould and William Hildebolt

Nine varieties of snap beans were grown on the Horticultural Farm at The Ohio State University. The beans were planted in 200 foot rows, 36 inches apart with the seed placed two to three inches apart in the row.

The beans were harvested by hand and transported immediately to the Fruit and Vegetable Processing and Technology Division Pilot Plant. They were prepared for canning and freezing. The beans were mechanically snipped, size graded, spray washed, steam blanched and hand packed twelve ounces into number 303 plain tin cans. Two size grades were used, 1-3 and 4-6, the latter were cut into pieces 1 to 1½ inches long, the smaller size grade were packed as whole beans. Blanch time varied from 2½ to 4 minutes depending on sieve size.

The beans were divided by variety and sieve size into two lots as follows:

1. One half for canning.

2. One half for freezing.

The beans for canning were covered with boiling distilled water and a thirty grain sodium chloride tablet was added to the can. The cans were exhausted for four minutes, steam flow closed (at 15 psi) and processed at 240° F for 20 minutes. The beans for freezing were sealed in the cans and frozen without further treatment.

Quality was determined as follows (the results as reported in the following tables are the average values where applicable):

Number of plants - The actual number of plants in 100 feet were pulled and counted for each of the harvests.

Yield - The beans were weighed to determine the gross yield in pounds for the number of plants in 100 foot rows.

Number of pods per pound - The number of pods in a one pound field run sample was counted.

Percent sieve size - Sieve size was determined by measuring the diameter of the pod perpendicular to the sutures. The sieve sizes of a one pound field run sample were determined and weighed. The percentage of each sieve size was then calculated.

Pod length - Pod length was determined by evaluating 20 pods as to minimum, maximum, and average length.

Vitamin C - A 20 gm. sample of snap beans were ground in a Waring Blendor for 3 minutes with 180 ml. of 1% meta phosphoric acid and filtered. A 10 ml. aliquot of the filtrate was titrated with 0.1% 2,6-dichlorophenolindophenol indicator solution. Milligrams of vitamin C were determined by the following formula:

$$\text{Dye factor} \times \text{ml. of dye} \times 100 = \frac{\text{mgm. Vit. C}}{\text{100 gms.}}$$

Percent by weight seeds - Determined on raw, canned and frozen products and reported in Tables I, II, and III by sieve size. For determining percent by weight seeds, 100 grams of pods for each sieve size was deseeded and the seeds weighed.

The grade for both the canned and frozen products by the respective attributes of quality was determined in accordance with the U.S. Standards for Grades of Canned and the U.S. Standards for Grades of Frozen Snap Beans. The actual score points assigned each of the attributes of quality are recorded by sieve size and harvest for each of the varieties as reported in Tables II and III.

TABLE IA - SNAP BEANS - VARIETY EVALUATION - 1966 - RAW PRODUCT DATA

Variety	Harvest	No. of Plants /100'	Lbs. Yield /100'	No. of Pods /lb.	Vit. C 1-3	Vit. C 4-6
Kinghorn Wax	1	213	18	133	23.27	23.27
	2	356	25	113	29.73	30.32
Earliwax	1	201	10.8	128	21.25	31.37
	2	346	25.6	145	26.82	32.07
Tenderwhite	1	433	9.5	107	20.75	16.19
	2	480	15.5	87	16.32	13.99
Greenpod #206	1	700	27	104	16.70	19.23
	2	757	34	104	27.86	27.86
	3	657	30	99	32.07	29.73
Slimgreen	1	402	11	134	24.79	25.30
	2	370	12.5	120	29.90	27.40
Greenpod #235	1	317	6.5	162	19.23	16.19
	2	200	9.5	126	19.24	18.07
63-317	1	219	1.75	126	18.74	20.26
64-407	1	465	8	155	26.85	26.34
64-478	1	325	6.8	189	18.74	17.73

TABLE IB. SNAP BEANS - VARIETY EVALUATION - 1966 - RAW PRODUCT DATA BY HARVEST 1, 2, and/or 3

Variety	Sieve Size	No./lb.		Yield %		% Seed		% Fiber		Pod Lengths in Inches: Min.		Max.		Ave.	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Kinghorn Wax	1	15	5	7	3						2		2.5		2.25
	2	17	6	9	4						1.5		3		2
	3	21	14	13	9	2.9		.03		1.75	1.25	3.5	3.75	2.5	2.25
	4	34	10	25	6	4.4		.03		2	1.25	3.5	3.5	2.5	2.5
	5	29	18	27	17	6.2	6.2	.04	.03	2.25	2	3.5	4	2.13	3.25
	6	17	50	19	61	6.5	13.5	.03	.06	2.13	1.5	4.13	4.5	3.25	3.5
Earliwax	1	16	23	6	6					2	1.75	3.5	3	2.25	2.5
	2	18	18	9	8					1.25	1.5	3.5	3.75	2.25	2.25
	3	33	20	26	11	3.0		.03		2	2	4.25	4.75	3.25	3.25
	4	42	29	38	21	3.7	6.7	.05	.06	2.5	2	3.75	4.25	4.75	3.25
	5	18	34	20	29	5.7	11.6	.02	.04	2	2.25	5	4.5	3.5	3.5
	6	1	21	1	25		16		.08	4	2.5	4	5.25	4	4
Tenderwhite	1	16	2	7	1					2.25	2.75	3.25	3	2.75	2.88
	2	12	3	8	1.5					2.25	2.75	3.75	3.5	3.5	3
	3	18	6	13	4.5	1.2		.02		2	2.5	4	4	3.25	4
	4	20	19	19	16	1.2	3.2	.04	.06	2.5	3	4.25	4.25	3.5	3.25
	5	29	16	35	16	1.8	6.5	.03	.12	2.5	2.5	4.5	4.5	3.25	4
	6	12	41	18	58	2.3	8.5	.02	.12	3	2.25	4.5	4.5	4.75	3.75

TABLE IB. SNAP BEANS - VARIETY EVALUATION - 1966 - RAW PRODUCT DATA BY HARVEST 1, 2, and/or 3

Variety	Sieve Size	Yield No./lb. 1	2	3	Yield % 1	2	3	% Seed 1	2	3	% Fiber 1	2	3	Pod Lengths in Inches Min. 1	2	3	Max. 1	2	3	Ave. 1	2	3
Greenpod #206	1	6	11	8	2	4	2							2.25	2	2.25	3	3.5	3	3.3	2.3	2.5
	2	16	7	9	9	5	3							1.5	3	2.5	4.5	3.5	3	3.5	3.3	2.5
	3	11	18	5	8	11	3		3.1			.04		2.5	2.5	2.25	4.5	4.25	4	3.3	3.5	3.3
	4	25	11	6	24	10	3	4.2			.03			3.0	3	2.25	4.75	4.75	3.5	3.8	3.8	2.8
	5	30	27	23	36	30	21	5.1	5.0	8.9	.03	.04		1.5	2.5	2.0	4.75	5.0	4.25	3.8	3.8	3.0
	6	16	30	48	21	40	68		5.0	7.1	.03	.05	.09	2.75	2	1.5	5.0	5.25	4.75	4	4	4.0
Slimgreen	1	25	3		11	1		1.6			.03			1.5	2		3.5	3.25		2.8	2.3	
	2	31	4		19	2								2	2.25		4.25	3		2.5	2.8	
	3	31	20		23	12		2.2	2.3		.02	.04		2	1.75		4	3.75		3	2.8	
	4	27	40		25	30		3.1	5.9		.02	.11		2	1.75		4.13	4		3	3	
	5	18	38		20	39		3.0	6.4		.04	.06		2	3		4.75	4.5		3.5	3.5	
	6	2	15		2	16			6.7			.07		2.5	2.75		4.25	4			3.5	
Greenpod #235	1	53	19		17	5		.9			.02			1	2		3.25	2.75		2.5	2.3	
	2	11	22		22	9		1.1			.05			2	1.5		3.75	3.25		2.5	2.3	
	3	19	13		14	9		1.2			.04			1.5	2		3.5	4		2.8	2.8	
	4	22	11		18	8		2.3			.03			2.25	1.75		4.25	3.75		3.3	3	
	5	16	15		15	12		3.0	3.2		.04	.07		1.5	2		3.75	4		3	3	
	6	11	46		14	57		4.6	6.4		.04	.02		2.25	1.75		3.75	4.5		2.8	3.3	

TABLE IB. SNAP BEANS - VARIETY EVALUATION - 1966 - RAW PRODUCT DATA BY HARVEST (1)

Variety	Sieve Size 1	No./lb. 1	% 1	% Seed 1	% Fiber 1	Pod Lengths in Inches Min. 1	Max. 1	Ave. 1
63-317	1	18	6			1.75	3.5	3
	2	26	16	1.2	.03	2	3.75	3
	3	29	23	1.2	.04	2	4	3.5
	4	32	31	2.0	.08	2.75	4.5	3.25
	5	19	22	2.2	.03	2	5.25	3.75
	6	2	2			3.25	3.75	3.5
64-407	1	14	5			2	3	2.5
	2	27	12	1.4	.08	2	3	2.5
	3	33	20	2.6	.06	2.5	4	3
	4	50	36	5.6	.05	2	4	3.25
	5	30	26	6.5	.06	2.5	4.75	3.25
	6	1	1					
64-478	1	37	11			1.5	2.75	2.25
	2	47	20	4.3	.07	1.75	3.5	2.5
	3	53	30	5.9	.09	2	4	3
	4	43	30	7.3	.04	2.5	3.75	2.75
	5	8	8			2.5	3.75	3.5
	6	1	1					

TABLE II. 1966 SNAP BEAN VARIETY EVALUATION
CANNED PRODUCT

Variety	Harvest	Style	Sieve Size	% Seed	U.S.D.A. Grade Factors: Liquor	Color	Abs. of Def.	Character	Total Score	Grade	Vit. C	Fiber
Kinghorn Wax	1	Whole	1-3	4.7	9	10	30	36	85	B	7.61	.057
	2	Whole	1-3	6.4	8	12	29	36	85	B	6.02	.062
				$\bar{x}$ 5.5	8.5	11	29.5	36	85	B	6.82	.060
	1	Cut	4-6	10	8	14	32	32	86	B	9.19	.051
	2	Cut	4-6	19.5	7	13	26	31	77	C	9.19	.062
				$\bar{x}$ 14.8	7.5	13.5	29	31.5	81.5	B	9.19	.057
Earliwax	1	Whole	1-3	6.25	8	12	32	36	88	B	7.93	.076
	2	Whole	1-3	7.6	8	10	27	35	80	C	6.34	.031
				$\bar{x}$ 6.93	8	11	29.5	35.5	84	B	7.14	.054
	1	Cut	4-6	8.9	8	14	34	33	89	B	8.24	.031
	2	Cut	4-6	24.2	7	14	27	30	80	C	9.19	.080
				$\bar{x}$ 16.6	7.5	14	30.5	31.5	84.5	B	8.72	.056
Tenderwhite #206	1	Whole	1-3	2.2	10	14	29	37	90	A	9.19	.010
	2	Whole	1-3	6.2	8	12	27	33	80	B	7.29	.107
				$\bar{x}$ 4.2	9	13	28	35	85	B	8.24	.059
	1	Cut	4-6	3.4	9	14	32	35	90	A	7.61	.048
	2	Cut	4-6	11.1	9	14	28	35	86	B	6.34	.193*
				$\bar{x}$ 7.3	9	14	30	35	88	B	6.98	.121
Greenpod	1	Whole	1-3	4.1	8	10	29	36	83	B	7.93	.051
	2	Whole	1-3	7.6	8	10	30	37	85	B	8.56	.095
	3	Whole	1-3	8.8	8	10	28	35	81	B	5.39	.076
				$\bar{x}$ 6.8	8	10	29	36	83	B	7.29	.074
	1	Cut	4-6	5.75	8	13	31	36	88	B	9.19	.053
	2	Cut	4-6	9.3	8	13	29	33	83	B	7.93	.070
	3	Cut	4-6	16.6	8	10	28	32	78	C	9.83	.130
				$\bar{x}$ 10.6	8	12	29.3	33.7	83	B	8.98	.084

TABLE II (Continued)

Variety	Harvest	Style	Sieve Size	% Seed	U.S.D.A. Grade Factors: Liquor	Color	Abs. of Def.	Character	Total Score	Grade	Vit. C	Fiber
Slimgreen	1	Whole	1-3	4.2	9	13	29	37	88	B	9.19	.045
	2	Whole	1-3	10.2	9	9	31	35	84	B	5.39	.115
			$\bar{x}$	7.2	9	11	30	36	86	B	7.29	.080
	1	Cut	4-6	7.9	8	14	28	35	85	B	8.56	.056
	2	Cut	4-6	13.9	8	13	32	36	89	B	6.34	.164*
			$\bar{x}$	10.9	8	13.5	30	35.5	87	B	7.45	.110
Greenpod #235	1	Whole	1-3	2.1	7	14	27	34	82	B	9.51	.069
	2	Whole	1-3	3.9	8	13	30	34	85	B	5.07	.070
			$\bar{x}$	3	7.5	13.5	28.5	34	83.5	B	7.29	.070
	2	Cut	4-6	10	10	13	30	36	89	B	6.66	.062
63-317	1	Whole	1-3	3.4	10	14	28	34	86	B	7.29	.025
	1	Cut	4-6	5.8	10	13	31	33	87	B	9.19	.080
64-407	1	Whole	1-3	10.45	9	14	30	33	86	B	7.93	.060
	1	Cut	4-6	12.5	10	14	30	33	87	B	7.61	.099
64-478	1	Whole	1-3	13.6	9	12	30	35	86	B	8.24	.039
	1	Cut	4-6	9.4	8	13	29	35	85	B	7.29	.061

* Exceeds fiber tolerance 0.15.

TABLE III. 1966 SNAP BEAN VARIETY EVALUATION
FROZEN PRODUCT

Variety	Harvest	Style	Sieve Size	% Seed	U.S.D.A. Grade Factors: Color	Abs. of Def.	Character	Total Score	Grade	Vit. C	Fiber
Kinghorn Wax	1	Whole	1-3	6	16	34	36	86	C	22.2	.079
	2	Whole	1-3	4	15	35	38	88	C	19.2	.029
				$\bar{x}$ 5	15.5	34.5	37	87	C	20.7	.054
	1	Cut	4-6	11.5	17	36	35	88	B	20.4	.030
	2	Cut	4-6	28.5	18	34	27	79	D	25.8	.115
				$\bar{x}$ 20	17.5	35	31	83.5	C	23.1	.073
Earliwax	1	Whole	1-3	7.5	15	35	36	86	C	19.2	.043
	2	Whole	1-3	4.1	15	34	38	87	C	18	.065
				$\bar{x}$ 5.8	15	34.5	37	86.5	C	18.6	.054
	1	Cut	4-6	7.5	18	38	36	92	A	22.2	.044
	2	Cut	4-6	21.4	18	36	30	84	C	29.4	.117
				$\bar{x}$ 14.45	18	37	33	88	B	25.8	.081
Tenderwhite	1	Whole	1-3	2.1	18	36	37	91	A	28.8	.043
	2	Whole	1-3	3.7	18	36	37	91	A	24.0	.221
				$\bar{x}$ 2.9	18	36	37	91	A	26.4	.132
	1	Cut	4-6	3.4	19	38	36	93	A	14.4	.023
	2	Cut	4-6	13	17	35	27	79	D	25.2	.166
				$\bar{x}$ 8.2	18	36.5	35.5	90	A	15.3	.095
Greenpod #206	1	Whole	1-3	4.2	18	34	38	90	B	22.8	.049
	2	Whole	1-3	7.8	18	35	36	89	B	24	.115
	3	Whole	1-3	9.4	19	33	38	90	B	20.4	.102
				$\bar{x}$ 7.13	18.3	34	37.3	89.7	B	22.4	.089
	1	Cut	4-6	5	18	32	35	85	B	21.6	.059
	2	Cut	4-6	9	18	33	35	86	B	23.4	.084
	3	Cut	4-6	14.5	18	34	35	87	B	24.6	.114
				$\bar{x}$ 9.5	18	33	35	86	B	23.2	.084

TABLE III (Continued)

Variety	Harvest	Style	Sieve Size		% Seed	USDA Grade Factors: Color	Abs. of Def.	Character	Total Score	Grade	Vit. C	Fiber
Slimgreen	1	Whole	1-3		4	18	37	38	93	A	30	.054
	2	Whole	1-3		8.5	18	34	37	89	B	16.8	.140
				$\bar{x}$	6.25	18	35.5	37.5	91	A	23.4	.099
	1	Cut	4-6		5.9	18	35	36	89	B	25.2	.049
	2	Cut	4-6		13.8	18	36	27	81	D	19.8	.188*
				$\bar{x}$	9.85	18	35.5	35.5	89	B	22.5	.119
Greenpod #235	1	Whole	1-3		3	20	39	39	98	A	18	.045
	2	Whole	1-3		3.9	19	38	38	95	A	24	.064
				$\bar{x}$	3.5	19.5	38.5	38.5	96.5	A	21	.055
	1	Cut	4-6		5.1	18	36	36	90	A	15	.035
	2	Cut	4-6		9.7	18	35	36	89	B	22.8	.050
				$\bar{x}$	7.4	18	35.5	36	89.5	A	18.9	.043
63-317	1	Whole	1-3		3.8	19	38	38	95	A	19.8	.090
	1	Cut	4-6		6.3	18	36	34	88	B	17.4	.096
64-407	1	Whole	1-3		7.2	18	38	38	94	A	24	.119
	1	Cut	4-6		11.9	18	39	35	92	B	24	.088
64-478	1	Whole	1-3		8.7	19	36	37	92	A	22.2	.069
	1	Cut	4-6		13.8	19	35	36	90	B	24	.108

* Exceeds fiber tolerance 0.15

EVALUATION OF VARIOUS GRAPE CULTIVARS FOR PROCESSING
I. TABLE WINES

by

J. F. Gallander

During the 1965 season, nine grape cultivars were processed and evaluated for their suitability in manufacturing dry table wines. The various grape cultivars used in this investigation were grown at the Southern Branch of the Ohio Agricultural Research and Development Center in Ripley, Ohio. Each cultivar was harvested at maturity and transported to the Department of Horticulture in Wooster, Ohio, for processing.

Before the fermentation was initiated, a representative sample of each received grape cultivar was analyzed for the following:

1. pH. The pH was determined by the glass electrode method (Beckman Zeromatic pH meter) using 10 ml. of grape juice diluted with 90 ml. of distilled water.

2. Total acids. A 10 ml. grape juice sample was directly titrated with a 0.1 Normal sodium hydroxide solution to a pH of 8.2. The percent total acids was calculated as tartaric.

3. Total soluble solids. The soluble solids content was determined by an Abbe refractometer.

4. Total sugars. The total sugar content of the grapes was determined by the Lane and Eynon procedure and was expressed as reducing sugars.

The percent total acids varied widely with Seibel 10878 having the highest percent, 0.99 and Yates the lowest percent, 0.48 (Table I). The cultivars highest in percent total sugars were: Yates (20.05), Seibel 10878 (18.87) and Seibel 5279 (18.40).

After the analysis of the raw product, each grape cultivar was fermented by a standard procedure. Briefly, the procedure was as follows: The received grapes were stemmed, crushed and treated with 100 ppm SO_2. After 24 hours, yeast was added and stirred twice daily for four days. Then, the crushed grapes were pressed and sugar was added to bring the original soluble solids content to 21%. After the fermentation was completed, the wines were racked at least 3 times and then bottled.

After a month's storage (34° F), the wines were analyzed for various chemical constituents and evaluated organoleptically (Table 2). The following chemical constituents were determined:

1. Total acids: The wine was titrated with a 0.1 Normal sodium hydroxide solution to a pH of 8.2. The percent total acids was calculated as tartaric.

TABLE I. RAW PRODUCT EVALUATION OF VARIOUS GRAPE CULTIVARS, 1965 SEASON

Cultivar	Harvest Date	Color	pH	Total Acids %	Soluble Solids %	Total Sugars %
Seibel 5279	Aug. 17	White	4.25	0.71	19.45	18.40
Seibel 9549	Aug. 17	Blue	3.80	0.89	16.93	15.76
Seibel 10878	Sept. 2	Blue	3.38	0.99	19.35	18.87
Yates	Sept. 2	Red	3.65	0.48	20.18	20.05
Baco #1	Sept. 7	Blue	3.64	0.98	18.90	16.75
Steuben	Sept. 7	Blue	3.43	0.58	17.30	14.97
Bokay	Sept. 7	White	3.35	0.90	15.64	13.80
S.V. 12375	Sept. 14	White	3.30	0.84	15.67	13.90
Sheridan	Sept. 14	Blue	3.45	0.69	15.59	12.92

TABLE II. EVALUATION OF WINES OF VARIOUS GRAPE CULTIVARS, 1965 SEASON

Cultivar	Analyses: Total Sugars %	Total Acids %	Alcohol %	Extract %	Tannin mg/100 ml	Quality Description
Baco #1	0.32	0.78	12.3	2.7	110	Oxidized, poor
Seibel 5279	0.15	0.64	13.3	2.0	25	Strong aroma, fair, off flavor
Yates	0.14	0.48	13.3	1.6	108	Labrusca, soft and fruity, good
Bokay	0.30	0.72	13.4	1.8	20	Natural, good
S.V. 12375	0.22	0.68	13.1	1.7	24	Neutral flavor and aroma, acid excellent
Steuben	0.21	0.63	13.7	1.8	89	Strong labrusca, fruity soft acid, good
Sheridan	0.22	0.69	13.4	1.6	69	Mild labrusca, good acid, fruity (mild) good
Seibel 9549	0.43	0.71	13.6	2.0	89	Excellent flavor and aroma, excellent
Seibel 10878	0.26	0.65	12.8	1.7	56	Good flavor and aroma, good

2. Total sugars: The total sugar content of the wines was determined by the Lane and Eynon procedure and was expressed as reducing sugars.

3. Alcohol: The alcohol content was determined by using an ebullioscope, Dujardin-Salleron type.

4. Tannin: The tannin content was determined by using the standard (Pro) procedure.

5, Extract: The extract of the wines was determined by taking the density of a dealcoholized sample.

RECOMMENDED FRUIT CARIETIES FOR CANNING AND FREEZING

by

James F. Gallander

One of the most important factors in producing a high quality processed fruit product is the selection of a suitable variety. The variety must be able to retain certain desirable characteristics (color, flavor and texture) after processing. Frequently, a particular variety of fruit is found to possess several desirable fresh fruit qualities, such as large yields, disease resistance and convenient maturity dates but cannot be recommended because of its poor canning and freezing quality. Since new varieties are constantly being developed and as the need for improved varieties for processing has greatly increased, the Research Center is conducting studies to ascertain the suitability of promising new varieties and selections for processing. The information from these investigations will serve as a guide in the selection of the most suitable varieties for canning and freezing.

This study included the evaluation of the following fruits: strawberries, blueberries, blackberries, black raspberries, apples and peaches. All varieties were grown in the horticultrual plots at the Research Center. During each season, the fruits were harvested at picking maturity and delivered to the Horticulture Building for processing. The fruits of each variety were sorted, washed, drained and processed in accordance with accepted methods. After the processed products were stored for approximately 6 months, each variety of fruit was evaluated by a taste panel for color, flavor and texture. Generally, the panel consisted of at least 8 members and each panelist was asked to score the product on a hedonic scale of 1 through 9 (5 and above being acceptable). The results were used as a basis in recommending fruit varieties for freezing and canning.

A. Strawberries, Frozen - After the berries were washed, the caps were removed and each berry was sliced in half. Then, four pounds of sliced berries were gently mixed with one pound of sugar until dissolved. The sliced berries were packed and sealed in moisture-vapor proof containers and were immediately placed in -15° F. storage.

   Recommended Varieties - Pocahontas, Surecrop, Midway, Earlidawn, Sparkle and Tennessee Beauty.

B. Blueberries, Frozen - After the berries of each variety were washed, they were packed in moisture-vapor proof containers and covered with 40 percent sucrose syrup. The filled containers were then sealed and placed in -15° F. storage.

   Recommended Varieties - Jersey, Coville, Dixi, Cabot, Earliblue, Berkeley, June, Adams, Atlantic and Pioneer.

C. Blackberries, Frozen - After the berries of each variety were washed, they were packed in moisture-vapor proof containers and covered with 40 percent sucrose syrup. The filled containers were then sealed and placed in -15° F. storage.

Recommended Varieties - Bailey, Darrow, Hendrick, Ebony King, Eldorado and Lucretia.

D. Black Raspberries, Frozen - After the berries of each variety were washed, they were packed in moisture-vapor proof containers and covered with 40 percent sucrose syrup. The filled containers were then sealed and placed in -15° F. storage.

Recommended Varieties - Dundee, Morrison, Bristol, Cumberland, Logan and Black Hawk.

E. Peaches, Frozen - After the peaches were cut in half and pits removed, the halves, cut side down, were placed in a steam chamber for approximately 75 seconds. Then, the peaches were sprayed with cold water and the peels were removed. The fruit was sliced directly into a moisture-vapor proof container and covered with chilled 40 percent sucrose syrup containing ascorbic acid (6 grams per gallon of syrup). The filled containers were then sealed and placed in -15° F. storage.

Recommended Varieties - Sunhigh, Elberta, Halehaven, Redhaven, Triogem, Kalhaven and Keystone.

F. Peaches, Canned - After the peaches were cut in half and pits removed, the halves, cut side down, were placed in a steam chamber for approximately 75 seconds. Then, the peaches were sprayed with cold water and the peels were removed. The fruit was sliced directly into a 15 percent sucrose syrup containing 6 grams of ascorbic acid per gallon. The slices were drained, packed into No. 303 cans and covered with hot 40 percent syrup. After steam exhausting for 5 minutes, the cans were sealed, processed for 10 minutes at 212° F. and cooled immediately to room temperature.

Recommended Varieties - Redhaven, Triogem, Fairhaven, Richaven and Sunhaven.

G. Apples, Canned - After peeling and coring, the raw apples were sliced and placed in a 3 percent salt (sodium chloride) solution. Slices were then drained and subjected to 28 inches of vacuum for 10 minutes. The vacuum was broken with steam, slices removed and flushed with cold water. The slices were then placed in No. 303 cans, covered with boiling water, sealed and processed for 10 minutes at 212° F. The cans were cooled immediately to room temperature.

Recommended Varieties - Stayman Winesap, Golden Delicious, Jonathan, Northern Spy and Melrose.

H. Apples, Frozen Pies - After peeling, coring and slicing, the raw apple slices were immediately placed in 3 percent salt (sodium chloride) solution. Then, the slices were used in a standard pie recipe which the crust and ingredients were essentially the same for each pie as well as the amount of each ingredient. After the pies (9 inches in diameter) were prepared, they were frozen and stored in a freezer at -15° F.

Recommended Varieties - Golden Delicious, Stayman Winesap, Jonathan, Rome Beauty and Melrose.

EVALUATION OF TOMATO VARIETIES FOR PROCESSING

by

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The 1966 Tomato Variety Trials included 11 varieties of tomatoes which were grown in replicated plots under acceptable commercial practices at the Ohio Agricultural Research and Development Center - Northwestern Branch, Hoytville, Ohio. Each variety was harvested 3 times, and following harvest the tomatoes were transported by truck (approximately 100 miles) to The Ohio State University, Columbus, Ohio for processing.

Quality was determined as follows (the results as reported in the following tables are the average values):

1. Size or average count per 25 pounds. A random sample of 25 pounds of tomatoes were weighed and the total number of tomatoes were determined.

2. Percent total acid as citric. The sample (raw or canned) used for pH determination was directly titrated using 0.1 Normal Sodium Hydroxide solution to a pH of 8.1. Calculations using the following equation were made:

$$\frac{\%\ \text{acid}}{\text{as citric}} = \frac{(\text{No. ml. of 0.1 N NaOH})(.0064)}{10\ \text{ml. sample}} \times 100$$

3. pH. The pH was determined by the glass electrode method (Beckman Zeromatic pH meter) using 10 ml. of tomato juice (raw or canned) diluted with 90 ml. of distilled water.

4. Juice Color. Agtron F samples of raw or canned tomato juice were presented to the Agtron F instrument in a standard plastic sample cup. The instrument was standardized, using a black plastic plate (Monsanto Lustrex 11250) as 0, and a red plastic plate (Monsanto Lustrex 11250) as 70. Readings were taken directly.

5. Percent soluble solids. An Abbe 3L refractometer was used for direct determinations of percent soluble solids on raw or canned juice. The instrument was standardized with distilled water and all readings converted to 20° C.

6. Grades of Canned Tomatoes. The grade was determined in accordance with the U.S. Standards for Grades of Canned Tomatoes.

7. Grades of Canned Tomato Juice. The grade was determined in accordance with the U.S. Standards for Grades of Canned Tomato Juice.

8. Viscosity. The viscosity was measured using the GOSUC efflux tube instrument containing a 5/64" opening and standardized at 23 seconds at 25° C with water. The rate of flow from the instrument was measured with a stop watch and the readings recorded directly.

9. Raw tomato cut surface color. A random sample of 20 raw tomatoes were cut in half and color measured on the Agtron E instrument. The "E" values reported are an average for the 20 tomatoes.

10. Vitamin C. Ten ml. aliquots of tomato juice were diluted with 90 ml. of 1% meta phosphoric acid and filtered. A 10 ml. aliquot of the filtrate was titrated with 0.2% 2, 6-dichorophenol-indophenol indicator solution. Milligrams of vitamin C were determined by the following formula:

$$\text{Dye factor} \times \text{ml. of dye} \times 100 = \frac{\text{mgm. Vit. C}}{\text{100 gms.}}$$

Preparation and Processing

All tomatoes were prepared and processed as either whole tomatoes or tomato juice according to acceptable commercial practices in the OSU Pilot Plant.

Each lot of whole tomatoes was filled to 11.5 - 12.0 oz. in No. 303 plain tin cans. The detailed data are presented in Tables I, II, and III.

TABLE I. 1966 RAW PRODUCT TOMATO VARIETY EVALUATIONS - OBJECTIVE QUALITY AND CHEMICAL ANALYSIS

Variety	Count/ 25 lbs.	Quality	Color-Agtron E	Color-Agtron F	pH	Total Acid	Soluble Solids
Bouncer (ROFG)	160	Field Run	46	38	4.55	.33	4.1
		#1	49	34	4.55	.39	4.1
		#2	75	58	4.42	.38	4.1
Libby 1626	149	Field Run	41	46	4.35	.44	4.7
		#1	30	26	4.53	.42	4.9
		#2	82	54	4.24	.49	4.6
Campbells 17	109	Field Run	36	38	4.34	.40	4.5
		#1	35	26	4.35	.35	3.9
		#2	61	54	4.20	.41	4.3
Heinz 1370	144	Field Run	47	60	4.38	.34	4.0
		#1	37	32	4.25	.42	4.3
		#2	74	82	4.05	.55	4.8
Campbells 1327	102	Field Run	40	50	4.30	.44	4.2
		#1	43	28	4.28	.42	4.2
		#2	80	78	4.19	.63	3.8
Campbells 19	90	Field Run	47	60	4.40	.40	4.5
		#1	40	32	4.22	.39	4.3
		#2	64	86	4.10	.47	4.3
VF 145-22	126	Field Run	42	44	4.49	.33	4.8
		#1	48	28	4.25	.36	3.6
		#2	72	80	4.15	.42	3.8
L 2624	-	Field Run	-	34	4.32	.34	4.4
H 1630	-	Field Run	38	27	4.21	.40	4.6
XP 627	-	Field Run	-	45	4.15	.38	4.1

TABLE II. GRADE AND OBJECTIVE EVALUATION OF TOMATO JUICE

Variety	U.S.D.A. Score Factors				Total Score	Grade	pH	Total Acid	Soluble Solids	Agtron F	Viscosity (Sec.)	Vit. C mgm/100 g.
	Color	Consistency	Abs. of Def.	Flavor								
Bouncer (ROFG)	30	15	15	38	98	A	4.3	.39	5.8	38	87.0	16.7
Libby 1626	30	15	15	38	98	A	4.3	.38	5.8	40	84.0	20.5
Campbell 17	30	15	15	40	100	A	4.4	.36	6.0	32	74.8	21.9
Libby 2624	30	15	15	38	98	A	4.3	.33	-	43	50.0	19.1
Heinz 1370	30	15	15	38	98	A	4.4	.37	5.7	31	84.6	20.0
Campbell 1327	30	15	15	40	100	A	4.4	.36	5.8	33	60.6	18.4
Campbell 19	30	15	15	40	100	A	4.4	.41	5.7	31	71.2	20.0

TABLE III. 1966 TOMATO VARIETY EVALUATION
GRADE AND OBJECTIVE EVALUATION OF WHOLE TOMATOES

Variety	Peel Method	pH	Total Acid	Drained Weight	Whole-ness	Color	Abs. of Def.	Total Score	Grade	Remarks
Bouncer (ROFG)	Steam	4.51	.294	18.3	18.7	27.3	28.3	92.7	A	
	Lye-Faspeel	4.6	.249	17	19.7	25.3*	30	92	B	
	Lye-1467	4.7	.23	18*	17.7	24.7*	30	90.3	B	
	$\bar{x}$	4.6	.258	17.8	18.7	25.8	29.4	91.7		
Libby 1626	Steam	4.4	.39	15.3**	18.3	27	30	90.3	B	
	Lye-1467	4.52	.339	14.7**	15*	25.7*	30	85.3	C	
	$\bar{x}$	4.46	.36	15.0	16.7	26.4	30	87.8		
Campbell 17	Steam	4.4	.416	18.3	19.3	28.7	27.3	93.7	A	Hard core and stem scar
	Lye-Faspeel	4.51	.339	16	18.3	25.3*	30	89.7	B	
	Lye-1467	4.59	.314	17	16.7	25.7*	28	87.3	B	
	$\bar{x}$	4.50	.356	17.1	18.1	26.6	28.4	90.2		
Libby 2624	Lye-Faspeel	4.4	.352	16	17	26.7*	27	88.7	B	
Heinz 1370	Steam	4.42	.346	16.3	18.7	23.7*	30	88.7	C	
	Lye-Faspeel	4.48	.371	15.7*	19	26*	28	88.7	B	
	Lye-1467	4.6	.352	18	17.3	27	30	92.3	A	
	$\bar{x}$	4.5	.356	16.7	18.3	25.6	29.3	89.9		
Campbell 1327	Steam	4.5	.378	15.7**	19	24.7*	28.7	88.0	B	Hard Core
	Lye-Faspeel	4.53	.333	15.7**	19.3	26*	27	88	B	Cans Detinned
	Lye-1467	4.3	.371	16	17	25.3*	25*	82.7	B	
	$\bar{x}$	4.4	.361	15.8	18.4	25.3	26.9	86.2		

TABLE III (Continued)

Variety	Peel Method	pH	Total Acid	Drained Weight	Whole-ness	Color	Abs. of Def.	Total Score	Grade	Remarks
Campbell 19	Steam	4.48	.371	16.3	20	25.7*	25*	87	B	Objectionable core and
	Lye-Faspeel	4.52	.358	17.3	20	26.7*	27.3	91.3	B	detinned
	Lye-1467	4.51	.378	16.7	19.3	27	25*	88	B	
	$\bar{x}$	4.50	.369	16.8	19.8	26.5	25.8	88.8		
VF 145-22	Steam	4.5	.294	15.3*	19.3	23.7*	28	87.3	C	Detinned
	Lye-Faspeel	4.7	.256	16	18.7	24.7*	27.7	87	B	
	Lye-1467	4.68	.269	17	18	25.7*	29	89.7	B	
	$\bar{x}$	4.63	.273	16.1	18.7	24.7	28.2	88.0		
Heinz 1630	Steam	4.49	.326	18	19.7	27.7	23.7*	89	C	Uncored
L 2624 H	Steam	4.4	.365	17	18.7	28.3	23*	87	C	Uncored
XP 627	Steam	4.4	.326	16	19.7	27	27	89.7	B	Uncored - Detinned

* Indicates Limiting Rule.

** Indicates Partial Limiting Rule.

THE EFFECT OF DIFFERENT LEVELS OF SUGAR AND ACID ON THE QUALITY OF APPLE FRUIT JUICE BLENDS

by

James Gallander and Harold Stammer

During 1966, the development of apple fruit juice blends was continued and over 300 blends were evaluated for flavor acceptance. Apple juice consisting of five apple cultivars was blended with juice of different percentages of the following fruits: strawberry, grape, cherry, peach, blueberry and black raspberry, (Table I). Each juice blend was adjusted with sugar and acid to provide a series of 10 different sugar-acid ratios (15 through 40). All blends were pasteurized and submitted to a taste panel for flavor evaluation on a hedonic scale of 1 through 9 (5 and above being acceptable). In addition, apple cider (fresh and pasteurized) was subjected to the taste panel for comparison (Table II).

The data of the flavor evaluation were statistically analyzed and the results are summarized as follows:

1. Fresh cider was rated significantly higher than pasteurized cider.

2. The optimum sugar-acid ratio for each apple-fruit juice blend was approximately 30.

3. All blends at the optimum sugar-acid ratio level were acceptable (above a score of 5.0) to the taste panel.

4. The effect of adjusting the sugar-acid ratio on the flavor score of each blend was greater than varying the percentage of apple juice.

5. The most preferred blend at the optimum sugar-acid ratio level (30) was 80% apple - 20% strawberry (7.3) and was scored higher than fresh (6.2) and pasteurized cider (5.7).

6. Several blends at the optimum sugar-acid ratio level were rated higher than pasteurized cider: all combinations of apple-grape, apple-strawberry, and apple-peach.

TABLE I. CHEMICAL ANALYSIS AND COMPOSITION OF VARIOUS APPLE FRUIT JUICE BLENDS

Percentage of Fruit Juice in Each Blend*		pH	Soluble Solids %	Total Acids %	Sugar-Acid Ratio
Apple	Grape				
50	50	3.45	15.6	0.62	25.1
60	40	3.50	15.0	0.59	25.2
70	30	3.50	14.5	0.55	26.2
80	20	3.53	14.0	0.51	27.2
90	10	3.55	13.6	0.47	28.7
Apple	Strawberry				
75	25	3.65	11.7	0.65	18.1
80	20	3.65	11.9	0.61	19.4
85	15	3.67	12.2	0.57	21.5
90	10	3.70	12.4	0.53	23.5
95	5	3.70	12.6	0.48	26.3
Apple	Peach				
50	50	3.80	13.4	0.56	23.9
60	40	3.80	13.2	0.54	24.4
70	30	3.83	13.1	0.52	25.2
80	20	3.83	13.0	0.49	26.3
90	10	3.85	12.9	0.47	27.6
Apple	B. Raspberry				
70	30	3.78	11.9	0.67	17.7
75	25	3.73	12.1	0.63	19.1
80	20	3.70	12.4	0.59	20.9
85	15	3.68	12.6	0.56	22.5
90	10	3.68	12.7	0.53	24.1
Apple	Cherry				
50	50	3.50	20.0	0.72	27.8
60	40	3.50	18.6	0.67	27.6
70	30	3.55	16.2	0.61	26.6
80	20	3.55	15.6	0.55	28.5
90	10	3.57	14.2	0.50	28.4
Apple	Blueberry				
75	25	3.55	12.9	0.61	21.3
80	20	3.60	12.9	0.58	22.2
85	15	3.65	12.9	0.55	23.3
90	10	3.70	12.9	0.54	23.8
95	5	3.70	12.9	0.50	25.8

* Juice was obtained from fresh fruits except cherry which was from frozen cherries (4 + 1 pack).

TABLE II. FLAVOR EVALUATION OF APPLE FRUIT JUICE BLENDS AT VARIOUS SUGAR-ACID RATIOS

Percentage of Fruit Juice in Each Blend		Flavor Score of Each Juice Blend at Various Sugar-Acid Ratios				
		20	25	30	35	40
Apple	Grape					
50	50	4.5	5.9	6.6	6.6	5.8
60	40	4.5	5.9	6.6	6.6	5.8
70	30	4.5	5.9	6.5	6.5	5.7
80	20	4.5	5.8	6.4	6.3	5.5
90	10	4.4	5.7	6.3	6.2	5.3
100	Past.	-	-	6.1	-	-
100	Fresh	-	-	6.7	-	-
Apple	Strawberry					
75	25	5.2	6.5	7.1	6.6	5.2
80	20	5.3	6.8	7.3	6.9	5.5
85	15	5.1	6.6	7.1	6.8	5.4
90	10	4.9	6.4	6.9	6.6	5.4
95	5	4.2	5.8	6.3	6.1	4.9
100	Past.	-	-	5.7	-	-
100	Fresh	-	-	6.2	-	-
Apple	Peach					
50	50	4.9	6.0	6.5	6.3	5.6
60	40	5.0	6.1	6.4	6.5	5.8
70	30	5.0	6.1	6.9	6.6	6.0
80	20	4.8	6.0	6.6	6.6	6.0
90	10	4.5	5.7	6.4	6.4	5.[illegible]
100	Past.	-	-	6.0	-	-
100	Fresh	-	-	6.7	-	

TABLE II. (Continued)

Percentage of Fruit Juice in Each Blend		Flavor Score of Each Juice Blend at Various Sugar-Acid Ratios				
		20	25	30	35	40
Apple	**B. Raspberry**					
70	30	5.1	6.0	6.2	5.6	4.4
75	25	5.0	5.9	6.1	5.5	4.3
80	20	4.9	5.8	6.0	5.5	4.3
85	15	5.0	5.8	6.1	5.5	-
90	10	5.0	5.9	6.2	5.6	4.4
100	**Past.**	-	-	6.6	-	-
100	**Fresh**	-	-	7.6	-	-
Apple	**Cherry**					
50	50	5.4	6.4	7.0	7.1	6.7
60	40	4.8	5.8	6.3	6.3	5.9
70	30	4.5	5.5	5.9	5.9	5.4
80	20	4.6	5.5	5.9	5.9	5.3
90	10	5.1	5.9	6.3	6.2	5.6
100	**Past.**	-	-	7.0	-	-
100	**Fresh**	-	-	7.6	-	-
Apple	**Blueberry**					
75	25	3.6	5.4	6.3	6.5	6.0
80	20	3.4	5.1	6.0	6.2	5.7
85	15	3.5	5.2	6.1	6.2	5.7
90	10	3.7	5.3	6.2	6.3	5.6
95	5	4.2	5.7	6.5	6.6	5.9
100	**Past.**	-	-	6.9	-	-
100	**Fresh**	-	-	7.9	-	-

EPIDERMAL SLOUGHING OF SNAP BEANS AS INFLUENCED BY PROCESSING VARIABLES

by

William Hildebolt and W. A. Gould

INTRODUCTION AND BACKGROUND

This study was initiated to investigate the effects of processing variables on the epidermal sloughing of snap beans. Four varieties were included in the study; Kinghorn Wax, Tenderwhite, Slimgreen, and Greenpod. The investigation was conducted over two harvesting and processing periods. The first period was used to establish trends which could be studied more closely during the second period.

Hirzel Canning Company donated approximately six hundred pounds of green beans of the variety Tenderwhite to initiate the first study period. The green beans for the second study were grown on the Horticulture Farm at The Ohio State University.

The snap beans were processed in the Fruit and Vegetable Processing and Technology Division's Pilot Plant utilizing pilot plant equipment to duplicate commercial processing operations.

PROCESSING PROCEDURE

In the first study period after snipping and cutting the beans were divided into equal lots. Each lot was then blanched at different times and temperatures respectfully. The temperatures ranged from 130° to 212°F. and the time ranged from one to four minutes. The individual lots were then divided in half, and then each half was covered with either a sodium chloride or calcium chloride brine. Each half lot was then divided again with one half exhausted prior to closure and the other half steam-vac closed. The product was then processed at at 240° F. for twenty minutes, cooled, and stored at room temperature until analyzed.

There were ten different blanch temperatures studied and each of these ten lots had a combination of three different treatments conducted on it (blanch time, salt additive, type of closure) for a total of twelve different variables in each lot.

SLOUGHING EVALUATION METHODS

The green beans were allowed to equilibrate in the can for three weeks before any evaluation was performed. Both objective and subjective methods were used to evaluate the degree of sloughing. The subjective method was simply inspecting the amount of sloughing present on handling of the snap beans. Score points from one to six were awarded according to the degree of sloughing of the epidermal layer of the beans. The following score chart was followed:

Score Point	Description
1	No sloughing present, the skins are resistant to pressure.
2	Isolated sloughing but not obvious. Skin shows some resistance to pressure.
3	Moderate sloughing, skin not resistant to force.
4	Obvious sloughing present which can be detrimental to quality.
5	Moderately severe sloughing, beans are slippery to handle.
6	Severe sloughing, slimy and deep epidermal sloughing present.

The objective method which was used was developed by Van Buren of Cornell in 1960. (3) A modification of this method was employed in this study. Ten pieces of cut beans or five whole beans were placed (this should represent approximately thirty grams of beans) in a 500 ml. Erlenmeyer flask and covered with 50 ml. of water. The flask is then stoppered and shaken vigorously approximately one hundred times in one minute. The bean slurry is then transferred from the Erlenmeyer to a 100 ml. graduated cylinder. The Erlenmeyer should be rinsed out with about 20 ml. of water and this added to the graduated cylinder. The final volume in the cylinder should be about 100 ml. The cylinder is then allowed to set for one hour after which the amount of sediment which rises to the top is measured in milliliters. Zero to six milliliters sediment is indicative of minor sloughing, 6 to 18 milliliters indicate moderate sloughing, greater than 15 ml. indicates severe sloughing. Although this method is not absolute, it did give reproducable results which corresponded well with the subjective evaluation.

RESULTS AND DISCUSSION

Results of each process variable are present in graphical form and a brief discussion of the results.

Variety, Maturity, and Environment

It has long been recognized that there is range in resistance to sloughing among varieties of green beans. This study was not concerned with the differences in sloughing between varieties and this factor was kept constant in both studies.

Also, another variable which may be present, but not considered in this study was the weather conditions at harvest. Huffington (1) suggested that rainy cool weather at time of harvest helps promote sloughing.

Maturity was held constant in both studies, but it must be noted that this is another factor influencing sloughing. McConnell (2) in a study conducted for the National Canners Association indicated that mature beans were more resistant to sloughing than immature beans, but sloughing in mature beans was more objectionable.

Blanch Time and Temperature

Of the variables used, blanching temperature had the greatest effect on the epidermic of green beans. This can be seen graphically in Figure I. This graph is a plot of averaging the results obtained regardless of the variables employed. Blanch temperatures in degrees Fahrenheit are plotted along the horizontal axis versus the milliliters of sediment obtained in the objective slough measurement. Contrary to popular opinion, the amount of sloughing is not a linear relationship with blanch temperature. In other words, sloughing does not necessarily increase with an increase in blanch temperature. In fact, as can be seen from the data, sloughing was present at both temperature extremes and the least amount of sloughing was found in the middle region. This same effect has been reported (3) previously, and it has been suggested that an enzyme known as pectin methylesterase was responsible for this phenomena. This enzyme has been found to be present in the bean pods in large amounts and reacts with the pectin after the beans have been heated by blanching to temperatures between 150° and 180° F. The enzyme changes pectin into an insoluble form which remains in the bean pod, and which consequently helps to reduce sloughing. If the blanch temperature is either too low or too high, the enzyme is either nonactivated or inactivated respectively. In either case, the beans are made more susceptible to sloughing because of the loss of pectin from the beans during processing. These areas of activation are shown in Figure I with 160°-180° area as the optimum blanching temperature for controlling sloughing.

Sodium Versus Calcium Brine Fill

The results of the study indicated that calcium added to the brine did, in fact help to reduce sloughing in all except the extreme blanch temperature regions. Using sodium chloride as a control, the results of the calcium chloride addition are presented in Figure II. Although the calcium addition did reduce sloughing in most instances, it has the added disadvantage of over firming the bean pod. In some cases, this firming can be detrimental to the final quality of the beans, thus, the addition of calcium as a means to reduce sloughing must be carefully controlled.

Steam-Vac Versus Exhaust Box Closure

The comparison of the two vacuumizing methods indicated that exhaust closure greatly increased the sloughing of the green beans at all blanch times and temperature. This indicated that the enzyme was probably inactivated during the exhaust box treatment; thus, stopping any activity of the enzymes. In the case of the steam-vac closure, the beans were not given any heat treatment, consequently, allowing the enzyme to con-

tinue to function. It must be noted that the above effect was true only if the enzyme was in the active form prior to closure. The results of this study are given in graphical form in Figure III.

The exhaust box may still have an application in processing green beans if control in the operation of some are exercised. That is, the temperature of the exhaust box must be controlled in order that a center can temperature of approximately 180° F. is maintained. This would allow the enzyme to catalyze the reaction for a longer period of time and thus more control of sloughing would be obtained. The control would be the length of time which the beans are exposed to the heat while in the exhaust box.

RECOMMENDATIONS

The most effective method of decreasing sloughing is to blanch the beans at 170° to 180° F., and to hold the beans in brine in the can at 170° F. for several minutes. Steam-vac closure is recommended over the exhaust box method. Calcium chloride can be used to help reduce sloughing, but this is not a cure all, and it should not be used indiscriminately. Obviously, the degree of hardness of the water is the determining factor.

Several combinations of the above variables should be employed to reduce sloughing in snap beans if the beans show tendencies to slough.

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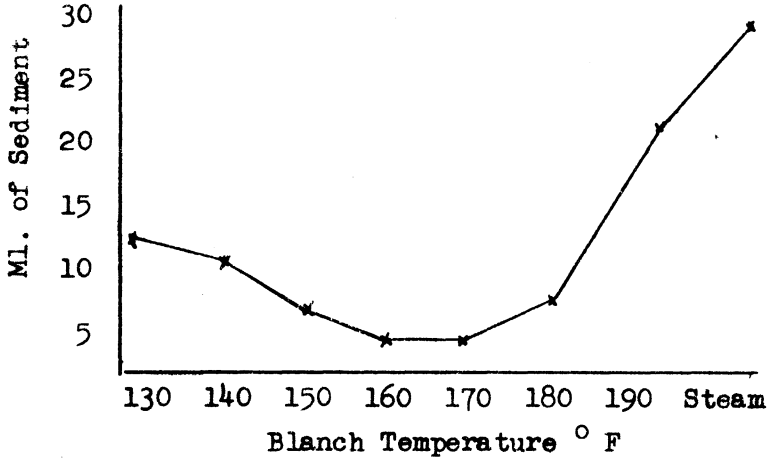

FIGURE I. This plot is an average of all results regardless of the variables employed. These data demonstratee a trend which is independent of all the variables except blanch temperature. The three areas which are marked off refer to the degree of activation of the enzyme pectin methylesterase. This enzyme is believed to greatly influence the epidermal sloughing of green beans and this seems to be supported by the graph.

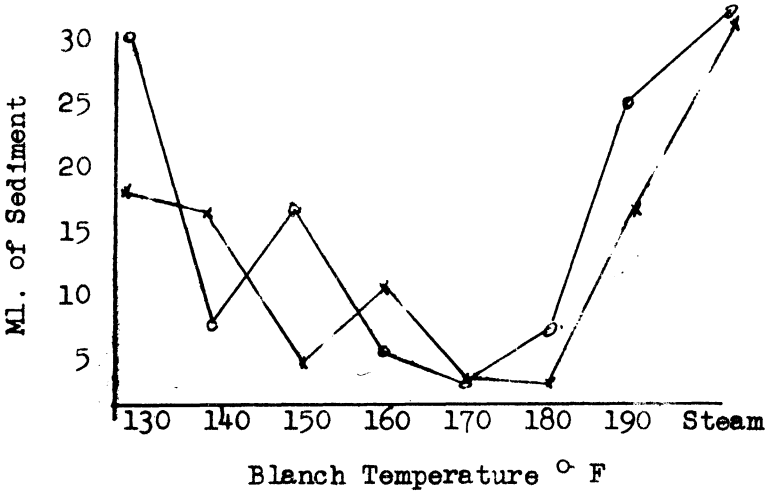

FIGURE II. This plot is an average of the two minute blanch. The purpose is to compare the Na salt against Ca salt fill. The sodium results are plotted by the solid line and the calcium are plotted by the broken line.

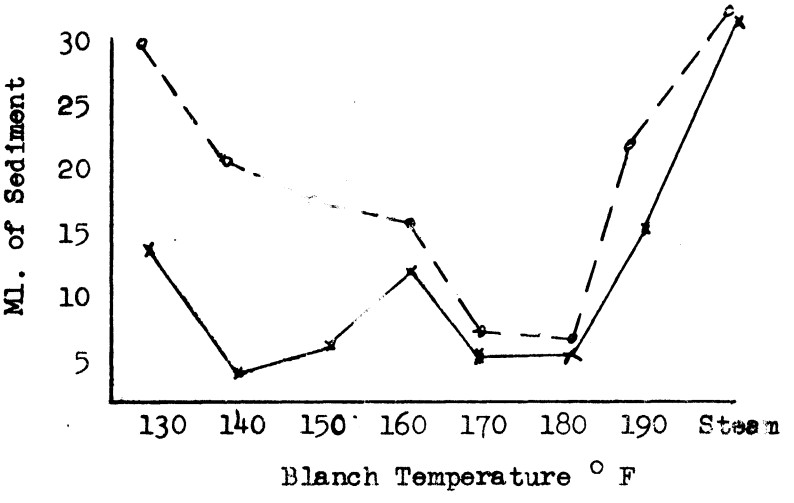

FIGURE III. This plot is an average of the two minute blanch. The purpose is to compare the steam vac closure against exhaust closure. The solid line is a plot of the steam closure and the broken line is the exhaust closure.

EFFECT OF STANNOUS CHLORIDE ON THE COLOR OF GLASS PACKED KRAUT

by

J. R. Geisman

One problem frequently encountered in sauerkraut packaged in glass containers is the discoloration due to exposure to light. This reaction occurs at a relatively slow rate with the end results of downgrading the quality of the product. This study was undertaken to determine whether stannous chloride could be added to sauerkraut packed in glass to prevent discoloration.

The addition of stannous chloride to asparagus is permitted by the Food and Drug Administration. The maximum content allowable was 15 ppm. The amounts added to sauerkraut for this experiment varied from 0 to 15 ppm by 2.5 ppm increments.

A standard procedure was utilized in filling, closing and storing. The acidity of the kraut was determined and standardized at 1.0 percent as lactic. The salt content was kept at 1.3 percent.

Kraut was heated to 165° F. and twelve ounces were filled into pint glass jars. The proper amount of stannous chloride was added. Hot brine (180° F.) was added to cover the shreds; approximately four ounces. The jars were steam-flow closed and allowed to cool.

The jars were placed at room temperature uncased for exposure to light. Visual observations were made at weekly intervals on the uniformity of color. Samples were opened after 1, 3 and 6 months storage. At these times pH, total acid and salt determinations were made. No changes in any of these attributes were noted during storage. In addition, objective color measurements were made utilizing the Agtron F color instrument. These data were compared to similar data obtained prior to packaging the kraut and are presented in Table I. This instrument was standardized at 30 on a gray disc (Monsanto Lustrex 5019.5) and at zero on a black disc (Monsanto Lustrex 00).

TABLE I. AGTRON COLOR VALUES FOR SAUERKRAUT STORED FOR 1, 3 AND 6 MONTHS CONTAINING VARIOUS CONCENTRATIONS OF STANNOUS CHLORIDE

Stannous Chloride (ppm)	Agtron F Color Values At			
	0 Month	1 Month	3 Months	6 Months
0.0	47	45	26	22
2.5		45	33	27
5.0		47	39	29
7.5		45	37	29
10.0		45	37	29
12.5		45	37	32
15.0		45	36	34

Since as Agtron values decrease, the color darkens, the data indicated that the kraut darkened throughout the storage period. Kraut with no stannous chloride added darkened considerably and was unacceptable after 3 months storage.

The least change in Agtron color value occurred with the samples containing 15 ppm stannous chloride. However, by visual observing the samples, it was noted that samples containing more than 5 ppm stannous chloride were not uniform in color. A precipitate was formed which turned some shreds black and there were definite light and dark layers within the package making the product unwholesome in appearance. Further investigations are underway to determine whether this objection can be overcome.

Concentrations less than five parts per million offer some promise in delaying or retarding darkening. This aspect is also under further investigation.

PROTEINS AND ENZYMES IN THE APPLE FRUIT IN RELATION TO VARIETY AND MATURATION

by

Robert L. Clements

Protein is the common chemical component of life, and is therefore found in all living cells. In general, the proteins are comprised of extremely complex and diversified molecules, and are highly susceptible to damage from various environmental influences, such as heat and chemicals. The proteins include the enzymes, those organic catalysts which regulate life processes, and which are generally considered to constitute the basis of biology.

In spite of the importance of the proteins, little information has been available regarding this class of compounds in the apple fruit. This lack of data has been due primarily to the difficulties associated with isolation of the proteins from apple tissue: (1) Apple cortical tissue ("pulp") contains very low levels of protein, generally less than 0.5%. (2) The tissue contains large amounts of acidic cell sap ("juice") which denatures most of the protein, converting it into products which bear little resemblence to the original biologically-active materials. (3) Apple tissue contains relatively large concentrations of phenols, which are responsible for browning, and which are capable of denaturing proteins.

Recently, the author developed a preparative procedure which appears to circumvent these difficulties. This process involves quick-freezing the tissue at -70° C (dry-ice temperature), followed by pulverizing in acetone at this temperature. The temperature of the suspension is raised to -25° C to dissolve tissue water (ice), and the solution is drawn off. The fine powder which remains is dried under vacuum, and proteins are extracted by suspension in buffer, followed by centrifugation. Data from seven varieties at three stages of maturity are presented in Table I. Solids and acid were also measured to provide an indication of maturation, and to serve as a chemical index of maturity. It may be noted that the powders contain approximately 0.3 - 0.6% nitrogen, which is equivalent to 2 - 4% protein. These powders are free of acids, phenols, and other deleterious low-molecular weight compounds present in the original tissue.

Electrophoretic studies of extracts of these powders have demonstrated that each sample contains 20 - 30 protein species in levels sufficiently high for detection. Undoubtedly, hundreds, or perhaps thousands, of protein species are present in lower concentrations, but are not detectable as proteins. The studies have shown that apple cortical tissue produces a characteristic protein profile, but that this profile varies slightly among varieties. The studies have also demonstrated that changes in the profiles occur during maturation and ripening, and there are indications that certain proteins increase in level during the ripening process.

The same electrophoretic techniques have also been utilized for enzyme studies. The enzymes, as proteins, are extracted and separated in the same manner. However, whereas proteins are detected with a general protein stain, specific enzymes are indicated by application of specific methods which detect only the enzyme in question. Such methods are far more sensitive than the protein detection procedure, and therefore have demonstrated many more enzymes than proteins.

These studies have demonstrated the presence of isozymes (or multiple forms) for most enzymes studied. Thus, eight amylases (enzymes which degrade starch) have been detected. Detection of esterases, malic dehydrogenases, acid phosphatases, and peroxidases have also demonstrated many isozymes. Single enzymes have been revealed for starch phosphorylase, malic enzyme and catalase. Differences in enzyme patterns among varieties have been demonstrated, and changes in these patterns during maturation and ripening are evident.

It is anticipated that further intensive application of these preparative and electrophoretic techniques, in conjunction with other analytical methods, will provide valuable information regarding the role of proteins and enzymes in the life cycle of the apple fruit. Such information can be of great value in understanding and controlling the chemical changes associated with ripening, and with various environmental conditions and treatments. The characteristics of processed commodities, as well as those of the raw fruit, are dependent upon the biochemical processes within the fruit during growth and maturation and after harvesting. The enzymes determine these processes. These studies will also aid in the measurement of maturity and quality.

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TABLE I. LOW-TEMPERATURE ACETONE EXTRACTS AND POWDERS OF CORTICAL TISSUE OF NINE VARIETIES OF APPLES AT THREE STAGES OF RIPENING.[a]

Variety and Date[b]	Wt. Per Fruit (g)	Sol. Solids: Percent of Fresh Wt.	Acid: Meq. per 100 g. Fresh Wt.	Acid: Percent of Sol. Solids (as Malic)	Acetone Pwdr: Percent of Fresh Wt.	Nitrogen: Percent of Acetone Pwdr.	Protein: Percent of Acetone Pwdr.
Golden Delicious (T)							
9-9	113	11.3	8.6	5.1	5.0	.37	2.3
10-12	157	13.9	8.2	3.9	3.2	.42	2.6
12-8	128	13.9	5.8	2.8	3.4	.47	2.9
Grimes Golden							
9-9	128	9.6	12.3	8.6	7.3	.25	1.6
10-12	113	11.3	5.4	3.2	2.8	.51	3.2
12-8	107	11.5	5.3	3.1	2.8	.61	3.8
Jonathan							
8-31	103	9.2	11.7	8.5	4.8	.32	2.0
10-12	113	12.3	7.7	4.2	2.2	.50	3.1
12-8	106	11.5	8.2	4.8	2.7	.51	3.2
Ruby							
9-9	158	8.3	8.5	6.9	5.5	.27	1.7
10-12	211	10.9	7.3	4.5	4.2	.36	2.2
12-8	206	10.3	5.5	3.6	2.6	.49	3.1
Rome Beauty							
9-9	130	9.0	6.2	4.6	4.5	.34	2.1
10-12	230	10.3	6.1	4.0	3.2	.42	2.6
12-8	205	10.3	5.0	3.2	2.8	.60	3.8
Red Delicious							
9-9	164	8.9	4.4	3.3	6.2	.25	1.6
10-12	139	11.2	3.9	2.3	4.3	.30	1.9
12-8	132	12.8	3.2	1.7	3.2	.49	3.1
Stayman Winesap							
9-9	162	9.2	10.8	7.9	6.3	.25	1.6
10-12	216	11.1	8.7	6.9	5.6	.30	1.9
12-8	173	13.6	6.7	3.3	2.8	.55	3.4

[a] Data obtained from measurements on single samples of each variety, each sample consisting of ten fruits.

[b] The first two dates are approximate dates on which fruit was picked and prepared immediately; on the third date, fruit from the second picking was removed from storage (4° C), held at 25° - 30° C for one week, and processed.

PROTEINS AND ENZYMES IN TOMATO FRUITS

by

Robert L. Clements

Protein content of the tomato fruit (less than 0.5%) is insignificant from the nutritional standpoint, and neither fresh fruit nor processed products may be expected to contribute substantial amounts of protein to the diet. However, the protein fraction of the fruit is of great importance from the biochemical standpoint, since it includes the enzymes. These substances, as regulators of cellular activities, determine the composition and behavior of the fruit during growth and ripening. Thus, the physical and chemical nature of the fruit is a function of the enzymes, and this is reflected in processing behavior and in character of the product.

Because of the low protein content of the tomato, and problems inherent in protein isolation from fleshy fruits, our knowledge of tomato proteins and enzymes is very limited. Recently, the author developed a technique for tissue preparation which facilitates such studies (See: "Proteins and Enzymes in the Apple Fruit in Relation to Variety and Maturation" in this Report), and this method has been applied to studies of placental tissue (the fleshy portion) of tomato fruits. The process involves homogenization at low temperatures (-60° C; -76° F), followed by extraction of water and low-molecular weight compounds (i.e., sugars, acids, phenols, amino acids, lipids, pigments, etc.). The resulting fine powder contains the protein, in addition to starch and such cell-wall constituents as cellulose, lignin and pectic compounds.

Preparations from six varieties at different stages of maturation are presented in Table I. During ripening, yield of powders (on a fresh-weight basis) declined, presumably because of decreasing levels of starch and other polysaccharides. However, concentration of protein in the powders increased to levels exceeding 20%. These powders were generally free of substances deleterious to proteins, and provided an excellent medium for protein and enzyme studies.

Extracts of these powders were subjected to disc electrophoresis, and generally revealed 20 - 30 proteins. Several bands were very intense, suggesting substantial levels of "bulk" or "non-functional" protein. Profiles from the different varieties at the same stage of maturation were essentially identical. However, distinct differences were evident between profiles of green and ripe fruit.

Disc electrophoresis was also utilized for detection of specific enzymes. Most of the enzymes which have been studied produced multiple bands, indicating isozymes (i.e., more than one enzyme catalyzing the same reaction). Certain enzymes (e.g., esterases, which hydrolyze esters) produced patterns which varied among varieties, and which also changed during maturation. Other patterns (e.g., acid phosphatase) did not demonstrate significant differences among varieties, but did demonstrate pronounced changes during ripening. Malic enzyme (involved in

acid metabolism) produced a single band which decreased in intensity during ripening. These examples, together with data regarding several other enzymes, suggest the enzyme complement of each variety may be unique, and characteristic changes occur during ripening.

To date, this study represents an approach, rather than an accumulation of useful data. Further application of the techniques to specific areas should aid in correlating biochemical processes in the fruit with chemical and physical characteristics. Sugars, acids, amino acids, pectic compounds, pigments, volatile flavor compounds and many other chemical components contribute to the character of a particular fruit, and these constituents are all regulated by the enzymes. Growth and ripening characteristics, firmness, juice content and color are all directly or indirectly determined by the enzymes. Ultimately, it is hoped that knowledge of the enzymes of the tomato will aid in evaluating varieties for raw consumption and processing, and in predicting and controlling characteristics of the processed product. Information regarding the enzymes can thus contribute not only to quality evaluation, but also to quality improvement.

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TABLE I. TOMATO POWDERS

Variety	Stage	Season	Powder %	Nitrogen % of Powder	Protein % of Powder	Protein % of Fresh Wt.
Golden Jubilee	Small green	1965	4.3	2.03	12.7	0.55
	Large green		2.9	2.41	15.1	.44
	Breaking		2.4	2.72	17.0	.41
	Ripe		2.3	3.05	19.1	.44
Golden Jubilee	Large green	1966	4.2	2.42	15.1	.63
	Breaking		2.3	3.04	19.0	.44
	Ripe		2.1	3.42	21.4	.45
Marglobe	Large green	1966	2.9	3.14	19.6	.57
	Ripe		2.2	3.82	23.9	.53
Rutgers	Large green	1966	2.4	3.56	22.3	.54
	Ripe		1.8	3.98	25.0	.45
Morton Hybrid	Large green	1966	1.8	2.52	15.8	.28
	Ripe		1.7	3.08	19.3	.33
Cardinal	Large green	1966	2.5	3.22	20.1	.50
	Ripe		1.7	3.35	20.9	.36

EFFECT OF FOOD ADDITIVES ON QUALITY OF CANNED TOMATOES

by

Wilbur A. Gould

With the approval of the amendment to the Standard of Identity for tomatoes by the Food and Drug Administration to acidify and sweeten canned tomatoes, a cooperative project was undertaken with the Morton Salt Company to determine the effect on product quality of a formulated tablet. The tablets were formulated according to the details in Table I.

Tomatoes of variety Heinz 1370 were used. They were machine harvested, water - ClO_2 (100 ppm) handled, hauled and held for 24 hours, lye peeled with a wetting agent (International Chemical Corp. No. 1467), filled 11.5-12 oz./303 plain can, covered with tomato juice with specific tablet added, exhausted 4½ minutes, steam flow closed (17 psi), processed 20 minutes in boiled water and cooked to 105° F.

After 3 months, storage at room temperature, six cans were graded according to U.S. Standards for Grades of Canned Tomatoes. pH and total acid were determined from a composite sample of the canned product. In addition, flavor was determined using a 10 member flavor panel scoring the product 10 (perfect) to 0 (off).

The flavor scores reported in Table I are average values. As can be observed from these data in Table I, the addition of acid to the tablets raised the titratable acid values from .16 to .21 above the check samples. The pH was reduced from 4.4 to a low of 4.1 for most of the lots. The effect of sugar is noted in the increase soluble solids up to 6.1%. It should be pointed out that the sample with the high salt only was scored the highest.

TABLE I. EFFECT OF FOOD ADDITIVES ON GRADE AND QUALITY OF CANNED TOMATOES

Tablet Formulas in Grains					Scores by Grade Factors									
Salt		Citric			Drained	Whole-		Abs. of	Total			Total	Soluble	
$CaCl_2$	NaCl	Acid	Sugar	Total	Weight	ness	Color	Def.	Score	Grade	pH	Acid	Solids	Flavor
5	20	0	0	25	16	18	26.7*	30	90.3	B	4.4	.371	5.2	6.0
5	45	0	0	50	15.3**	19.3	28.0	29.7	92.3	B	4.3	.40	5.2	6.8
5	20	15	15	55	16.7	17	26.7*	30	90	B	4.19	.582	5.3	4.3
5	20	15	30	70	16.7	20	28	30	94.7	A	4.1	.576	5.6	4.9
5	20	15	45	85	15.7**	20	29	29.7	94.3	B	4.1	.531	5.6	6.0
5	45	15	15	80	15**	18.7	28.7	30	92	B	4.1	.589	5.5	6.4
5	45	15	30	95	19	17	27	30	93	A	4.1	.531	6.1	5.5
5	45	15	45	110	18	16.7	25.7*	30	90	B	4.1	.538	6.1	5.1

* Indicates Limiting Rule.

** Indicates Partial Limiting Rule.

LSD for flavor scores equals 0.9

EFFECTS OF SELECTIVE HERBICIDES ON THE COMPOSITION AND QUALITY OF TOMATOES

by

W. A. Gould, J. R. Geisman, E. K. Alban and John Deppen

This project was undertaken in an effort to determine whether herbicides recommended for use on tomatoes resulted in any detrimental effects on the quality and composition of the raw product or the processed product; and whether processing techniques might result in favorable or unfavorable effects on the finished product, following the use of herbicides with these crops.

Herbicides used with tomato (variety Heinz 1370), included: (a) Dacthal at 8.0 lb/A and 16.0 lb/A; (b) Vegiben at 4.0 lb/A and 8.0 lb/A; and (c) Dymid at 6.0 lb/A and 12.0 lb/A. All treatments were applied after tomatoes were transplanted into the field in the 1965 and 1966 season.

The crop was harvested mechanically and transported to the Fruit and Vegetable Processing and Technology Division Pilot Plant for analysis and processing. There were two aspects of this work, production and processing phase concerning tomatoes will be reported herein.

Analysis of the Raw Material

The raw material was evaluated for size, grade, pH, total acid, soluble solids, objective color utilizing both the Agtron E and F, and Vitamin C content. In addition, analysis for residues was performed by both chromatographic and radiochemical techniques.

Processing

Each herbicide treatment was divided into three lots for manufacture into tomato juice. These lots were washed using detergents (2500 ppm) in the soak tank and the final rinse pressure was varied from 50 to 100 to 150 psi, respectively. The tomatoes were extracted, pasteurized at 240° F. for 2½ minutes, cooled to 205° F. filled, sealed, held for 3 minutes, and cooled to 95° F. prior to casing and storage.

Analysis of the Finished Product

In addition to the previously mentioned attributes measured on the raw product, the viscosity and grade of the canned tomato juice was determined. The data were analyzed statistically.

Results

A comparison of the quality attributes of the raw product (Table I) indicated that the treatments had no affect on quality. The only herbicide to produce a residue in the raw product was Dacthal.

The finished product data are reported in Table II. The results indicated that the only attribute affected by herbicide treatment was U.S.D.A. flavor score. Dymid, 12 lbs/A, and Vegiben, 4 lbs/A, treatments were scored significantly higher than the check. Other treatments except 16 lbs/A Dacthal were rated higher than the check but not significantly higher.

Harvest date produced significant differences in vitamin C content and highly significant differences in U.S.D.A. flavor score, pH, total acid, Agtron color and viscosity. U.S.D.A. color score and soluble solids were unaffected by harvest date.

Washing treatment had no effect on the quality of the finished product.

No residues have been found in the finished product.

TABLE I. QUALITY EVALUATION OF TOMATOES
RAW PRODUCT BY HARVEST

Treatment	Rate	Harvest Date	pH	Total Acid	% Soluble Solids	Agtron	Vitamin C	Residue (ppm)
Dymid	6 lbs/A	9/14	4.11	.47	4.40	58.9	17.0	0.0
		9/24	4.35	.49	4.80	45.8	34.3	0.0
Dymid	12 lbs/A	9/14	4.00	.49	4.20	69.8	13.2	0.0
		9/24	4.35	.44	5.00	47.2	35.5	0.0
Vegiben	4 lbs/A	9/14	4.02	.46	4.10	50.7	16.4	0.0
		9/24	4.31	.49	4.50	49.7	24.1	0.0
Vegiben	8 lbs/A	9/14	3.94	.52	4.30	63.9	15.7	0.0
		9/24	4.39	.42	4.60	46.9	31.9	0.0
Dacthal	8 lbs/A	9/14	4.05	.43	4.22	50.4	19.0	0.2
		9/24	4.38	.46	4.40	38.9	23.5	0.2
Dacthal	16 lbs/A	9/14	4.05	.48	4.40	51.7	18.6	0.68
		9/24	4.15	.35	4.50	34.9	28.9	0.65
Check (Cultivated)		9/14	4.22	.43	4.00	53.6	20.8	0.0
		9/24	4.49	.49	3.90	54.6	31.0	0.0
Treatments			NS	NS	NS	NS	NS	
Harvest Date			.01	NS	.05	.05	.01	

TABLE II. QUALITY EVALUATION OF CANNED TOMATO JUICE (3 MONTHS) BY TREATMENTS, WASHING METHODS AND HARVEST DATES

Treatment Code	Wash Methods	U.S.D.A. Color 9/14	U.S.D.A. Color 9/24	$\bar{x}$	U.S.D.A. Color 9/14	U.S.D.A. Color 9/24	$\bar{x}$
A	1	26	27	26.5	36	35	35.5
	2	26	26	26.0	35	35	35.0
	3	26	27	26.5	35	37	36.0
	$\bar{x}$	26.0	26.7	26.3	35.3	35.7	35.5
B	1	28	26	27.0	36	38	37.0
	2	26	26	26.0	35	38	36.5
	3	25	26	25.5	36	36	36.0
	$\bar{x}$	26.3	26.0	26.3	35.7	37.3	36.5
C	1	27	28	27.5	36	38	37.0
	2	25	27	26.0	36	38	37.0
	3	27	28	27.5	36	36	36.0
	$\bar{x}$	26.3	27.7	27.0	36.0	37.3	36.7
D	1	25	25	25.0	36	35	35.5
	2	28	26	27.0	33	36	34.5
	3	26	26	26.0	35	36	35.5
	$\bar{x}$	26.3	25.7	26.0	34.7	35.7	35.2
E	1	26	25	25.5	35	35	35.0
	2	25	27	26.0	35	36	35.5
	3	25	28	26.5	36	38	37.0
	$\bar{x}$	25.3	26.7	26.0	35.3	36.3	35.8
F	1	24	27	25.5	30	35	32.5
	2	24	25	24.5	30	36	33.0
	3	25	27	26.0	36	38	37.0
	$\bar{x}$	24.3	26.3	25.3	32	36.3	34.2
G	1	27	24	25.5	35	35	35.0
	2	25	25	25.0	33	36	34.5
	3	24	26	25.0	33	37	35.0
	$\bar{x}$	25.3	25.0	25.2	33.7	36.0	34.8
	$\bar{\bar{x}}$	25.7	26.3		34.7	36.4	
	$\bar{x}$	1	2	3 $\bar{x}$	1	2	3
		26.1	25.8	26.1	35.4	35.1	36.1

Source	F	LSD	F	LSD
Treatment	NS	-	.05	1.13
Harvest Date	NS	-	.01	1.06
Wash	NS	-	NS	-
T X HD	NS	-	NS	-
T X W	NS	-	NS	-
HD X W	NS	-	NS	-

TABLE II (Continued)

Treatment Code	Wash Methods	pH 9/14	pH 9/24	pH $\bar{x}$	Total Acid 9/14	Total Acid 9/24	Total Acid $\bar{x}$
A	1	4.2	4.2	4.20	.45	.42	.435
	2	4.3	4.4	4.35	.45	.44	.445
	3	4.2	4.3	4.25	.45	.47	.460
	$\bar{x}$	4.23	4.30	4.27	.450	.443	.447
B	1	4.25	4.4	4.32	.45	.41	.43
	2	4.21	4.3	4.25	.48	.41	.445
	3	4.2	4.4	4.30	.47	.39	.43
	$\bar{x}$	4.22	4.37	4.29	.467	.403	.435
C	1	4.2	4.3	4.25	.44	.42	.43
	2	4.3	4.4	4.35	.42	.42	.42
	3	4.2	4.3	4.25	.43	.42	.425
	$\bar{x}$	4.23	4.33	4.28	.430	.420	.425
D	1	4.2	4.3	4.25	.45	.40	.425
	2	4.3	4.3	4.3	.47	.40	.435
	3	4.3	4.3	4.3	.48	.40	.44
	$\bar{x}$	4.27	4.3	4.28	.467	.400	.433
E	1	4.3	4.3	4.3	.44	.42	.43
	2	4.2	4.3	4.25	.46	.42	.44
	3	4.2	4.4	4.3	.47	.42	.445
	$\bar{x}$	4.23	4.33	4.28	.457	.420	.438
F	1	4.3	4.4	4.35	.42	.40	.41
	2	4.2	4.3	4.25	.43	.42	.425
	3	4.2	4.3	4.25	.44	.43	.435
	$\bar{x}$	4.23	4.33	4.28	.430	.417	.423
G	1	4.3	4.3	4.3	.41	.44	.425
	2	4.3	4.3	4.3	.44	.41	.425
	3	4.3	4.3	4.3	.45	.41	.43
	$\bar{x}$	4.3	4.3	4.3	.433	.420	.427
	$\bar{x}$	4.25	4.32		.448	.418	
		1	2	3	1	2	3
	$\bar{x}$	4.28	4.29	4.28 $\bar{x}$	.426	.433	.438

Source	F	LSD	F	LSD
Treatment	NS	-	NS	-
Harvest Date	.01	.035	.01	.014
Wash	NS	-	NS	-
T X HD	NS	-	.05	.036
T X W	.05	.062	NS	-
HD X W	NS	-	NS	-

TABLE II (Continued)

Treatment Code	Wash Methods	Soluble Solids 9/14	9/24	$\bar{x}$	Viscosity 9/14	9/24	$\bar{x}$
A	1	5.4	5.7	5.55	52	53	52.5
	2	5.5	6.0	5.75	60	49	54.5
	3	5.7	5.9	5.80	59	56	57.5
	$\bar{x}$	5.53	5.87	5.70	57.0	52.67	54.83
B	1	6.2	5.5	5.85	59	57	58.0
	2	5.4	5.6	5.5	56	47	51.5
	3	5.8	5.8	5.80	67	52	59.5
	$\bar{x}$	5.80	5.63	5.72	60.67	52.0	56.33
C	1	5.6	5.6	5.60	59	48	53.5
	2	5.8	5.6	5.70	58	48	53.0
	3	5.5	5.7	5.60	56	49	52.5
	$\bar{x}$	5.63	5.63	5.63	57.67	48.33	53.0
D	1	5.5	5.4	5.45	65	50	57.5
	2	5.7	5.6	5.65	53	49	51.0
	3	5.8	6.3	6.05	66	50	58.0
	$\bar{x}$	5.67	5.77	5.72	61.33	49.67	55.5
E	1	6.3	5.5	5.90	72	48	60.0
	2	5.8	5.9	5.85	53	54	53.5
	3	5.9	5.6	5.75	56	53	54.5
	$\bar{x}$	6.00	5.67	5.83	60.33	51.67	56.0
F	1	5.6	5.8	5.70	65	53	59.0
	2	5.4	5.8	5.60	57	52	54.5
	3	5.6	5.8	5.70	54	53	53.5
	$\bar{x}$	5.53	5.8	5.67	58.67	52.67	55.67
G	1	4.7	6.0	5.35	50	56	53.0
	2	5.4	5.6	5.50	56	51	53.5
	3	5.6	5.4	5.50	61	52	56.5
	$\bar{x}$	5.23	5.67	5.45	55.67	53.0	54.33
	$\bar{x}$	5.63	5.72		58.76	51.43	
		1	2	3	1	2	3
	$\bar{x}$	5.63	5.65	5.74	56.21	53.07	56.0

Source	F	LSD	F	LSD
Treatment	NS	-	NS	-
Harvest Date	NS	-	.01	5.39
Wash	NS	-	NS	-
T X HD	NS	-	NS	-
T X W	NS	-	NS	-
HD X W	NS	-	NS	-

TABLE II (Continued)

Treatment Code	Wash Methods	Vitamin C 9/14	Vitamin C 9/24	Vitamin C $\bar{x}$	Agtron F 9/14	Agtron F 9/24	Agtron F $\bar{x}$
A	1	18.6	19.5	19.05	52	48	50.0
	2	18.1	19.5	18.80	52	50	51.0
	3	18.6	18.1	18.35	54	50	52.0
	$\bar{x}$	18.43	19.03	18.73	52.67	49.33	51.0
B	1	17.7	19.8	18.75	56	46	51
	2	18.1	21.4	19.75	56	46	51
	3	17.7	20.9	19.30	56	48	52
	$\bar{x}$	17.83	20.7	19.27	56	46.67	51.3
C	1	18.6	19.9	19.25	54	48	51
	2	19.5	18.1	18.80	56	46	51
	3	18.6	18.4	18.5	42	46	44
	$\bar{x}$	18.9	18.8	18.85	50.67	46.67	48.7
D	1	18.1	20.0	19.05	55	50	52.5
	2	19.5	20.0	19.75	54	48	51
	3	20.0	19.0	19.50	54	48	51
	$\bar{x}$	19.2	19.67	19.43	54.33	48.67	51.5
E	1	18.9	17.9	18.4	50	48	49
	2	19.1	19.1	19.1	54	47	50.5
	3	19.1	19.5	19.3	54	46	50
	$\bar{x}$	19.03	18.83	18.93	52.67	47	49.83
F	1	17.7	19.5	18.6	56	48	52
	2	17.7	18.6	18.15	55	46	50.5
	3	17.2	18.1	17.65	56	46	51
	$\bar{x}$	17.53	18.73	18.13	55.67	46.67	51.17
G	1	13.9	19.1	16.5	56	51	53.5
	2	19.5	17.9	18.7	54	48	51
	3	15.4	21.4	18.4	62	52	57
	$\bar{x}$	16.27	19.47	17.87	57.33	50.33	53.83
	$\bar{\bar{x}}$	18.17	19.32		54.19	47.91	
		1	2	3	1	2	3
	$\bar{x}$	18.51	19.01	18.71	51.28	50.86	51.0

Source	F	LSD	F	LSD
Treatment	NS	-	NS	-
Harvest Date	.05	1.52	.01	2.27
Wash	NS	-	NS	-
T X HD	NS	-	NS	-
T X W	NS	-	NS	-
HD X W	NS	-	NS	-

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

by

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This research was undertaken as a regional project with Ohio conducting experiments in the area of defoliant chemicals used on tomatoes and potatoes. Of particular concern is the influence of preparation procedures and processing techniques on removing, reducing or detoxifying pesticide residues.

The tomatoes were obtained from the Northwest Branch of the Ohio Agricultural Research and Development Center, Hoytville while the potatoes were obtained from The Ohio State University Horticulture Farm, Columbus. Commercially accepted cultural practices were followed for both commodities with defoliant treatments applied to the plants prior to harvest. Rates and treatments are indicated in Table I.

TABLE I. CONCENTRATION OF DEFOLIANT CHEMICALS APPLIED TO TOMATOES AND POTATOES

Chemical	Concentrations Applied To Tomatoes	Potatoes
Paraquat*	½ pint/A	1 & 2 pts/A
Shed-a-leaf**	3 & 4 lbs/A	0
Sodium Arsenite	0	6 & 12 lbs/A

* Chemically this product is 1:1'dimethyl-4,4'dipyridilium dichloride.

** Chemically this product is a sodium chlorate/borate mixture.

Both commodities were harvested mechanically. An untreated control lot as well as the treated sampled were harvested at 4 and 11 days after application for tomatoes and 7 and 15 days after application for potatoes.

Handling

Tomatoes from both the treated and untreated plots were harvested into bulk containers holding approximately 300 pounds of fruit. Three handling systems were used to determine whether residues could be removed or reduced by handling treatments. These were: dry, water with 500 ppm chlorine (sodium hypochlorite), and water with 500 ppm chlorine (sodium

hypochlorite) plus 2500 ppm tomato washing compound. The fruits remained in these treatments while being transported to Columbus (approximately 110 miles) for a maximum of 10 hours following harvest prior to processing. On the other hand, lots of the potatoes were placed in 35°, 55°, and 70° F. for periods of 0, 1, and 3 months prior to processing. When the tubers were removed from storage, each lot was conditioned for 1, 10, and 20 days before being processed.

Analysis of Raw Material

The raw product was evaluated for quality as well as for defoliant residue. Quality evaluations of the tomatoes included: pH, total acid, soluble solids, vitamin C content, and objective color using Agtron E and Agtron F instruments. Potatoes were evaluated for specific gravity and size.

Determinations of residues were carried out according to standard procedures utilizing chromatographic techniques. In addition, a newer technique, neutron activation analysis was also utilized to determine residues. The results are presented in Tables II and III.

Processing

Each handling treatment was divided so that a portion of the fruit was peeled by two methods and the remainder was manufactured into tomato juice. One half of each lot of the tomatoes was peeled conventionally using a 45 second steam scald and the other half was peeled using a hot (180° F.) 15% lye solution. The fruits were filled into #303 fruit enameled cans, sealed, and processed at 220° F. for 20 minutes.

The tomatoes to be manufactured into tomato juice were divided into two lots: one was washed under 100 psi spray rinse and the other lot was washed at 150 psi. For both lots, the tomatoes were conveyed under the spray rinse with a roller conveyor and the fruit made 2½ revolutions under the spraying system. The tomatoes were extracted, pasteurized at 240° F. for 2½ minutes, cooled to 205° F. filled, sealed, held for 3 minutes, and cooled to 95° F. prior to casing and storage.

The potatoes were sliced (18 slices to the inch) and washed in cold (60° F.) water. The slices were divided into two lots. One was fried at 375° F. and the other at 350° F. in a continuous chip fryer using peanut oil.

Analysis of the Finished Products

The same analyses that were performed on the raw product were also done on the finished product. In addition, the grade of whole tomatoes and tomato juice and the viscosity of the juice was determined. For potatoes, Coughlin Color, Agtron F color and percent yield were determined. These results are presented in Table IV, V and VI.

The residue determinations indicated that no residues of any of the defoliants were found in either of the processed products. The conclusions drawn from this study are:

1. No differences in quality or processing have been obtained for the various treatments for tomatoes.

2. Sodium arsenite produced a definite lowering in quality of both raw and processed potatoes.

3. No residues were found in any of the processed products included in this study.

TABLE II. TOMATO RAW PRODUCT OBJECTIVE QUALITY EVALUATION AND CHEMICAL ANALYSIS BY DEFOLIANT AND HARVEST DATE

Defoliant	Rate	Harvest Date		pH	Total Acid	Soluble Solids	Agtron F	Agtron E	Vit. C Mgm/100g	Residue (ppm)
Shed-a-leaf	4 lbs/A	9/14		4.40	.41	4.63	30.0	44.4	21.9	6.31
		9/21		4.41	.39	4.01	26.2	38.5	22.3	8.68
			$\bar{x}$	4.40	.40	4.32	28.1	41.4	22.1	7.49
Shed-a-leaf	3 lbs/A	9/14		4.45	.38	4.73	26.8	40.1	24.5	12.95
		9/21		4.42	.37	3.83	26.8	39.2	18.4	4.73
			$\bar{x}$	4.44	.38	4.28	26.8	39.7	21.5	10.08
Paraquat	½ pt/A	9/14		4.45	.39	4.53	28.8	43.0	20.8	0.83
		9/21		4.45	.37	4.06	24.0	41.5	22.4	0.91
			$\bar{x}$	4.45	.38	4.30	26.4	42.3	21.6	0.87
Control	0	9/14		4.47	.39	4.49	29.2	45.4	21.8	0
		9/21		4.41	.40	4.05	24.8	39.9	22.0	0
			$\bar{x}$	4.44	.39	4.27	27.0	42.6	21.9	0

TABLE III. RAW PRODUCT OBJECTIVE QUALITY EVALUATION AND CHEMICAL ANALYSIS BY DEFOLIANT AND HARVEST DATE

Defoliant	Rate	Harvest Date		Specific Gravity	Count/ 8 lbs	Residue (ppm)
Sodium Arsenite	6 lbs/A	10/13		1.058	27	0
		10/18		1.062	19	0
			$\bar{x}$	1.060	23	0
Sodium Arsenite	12 lbs/A	10/13		-	-	0
		10/18		1.058	14	0
			$\bar{x}$	1.058	14	0
Paraquat	1 pt/A	10/13		1.071	16	0
		10/18		1.065	16	0
			$\bar{x}$	1.068	16	0
Paraquat	2 pt/A	10/13		1.061	19	0.2
		10/18		-	19	0.0
			$\bar{x}$	1.061	19	0.1
Control	0	10/13		1.071	26	0
		10/18		1.066	16	0
			$\bar{x}$	1.068	21	0

TABLE IV. GRADE AND OBJECTIVE EVALUATION OF CANNED TOMATOES

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment[c,d]	pH	Total Acid	U.S.D.A. Grade Factors: Drained Weight	Wholeness	Color	Abs. of Defects	Total Score	Grade
Shed-a-leaf	4 lb/A	9/14	Dry	c	4.30	.37	16.8	16.8	27.8	30	91.4	A
		9/21		c	4.33	.42	18.8	18.0	26.6[a]	30	93.4	B
		9/14		d	4.50	.39	18.1	17.1	27.0	30	92.2	A
		9/14	Cl	c	4.30	.38	15.3[b]	14.5[a]	24.7[a]	29.8	84.3	C
		9/21		c	4.27	.44	15.5[b]	16.0	25.6[a]	29.8	86.9	B
		9/14		d	4.38	.43	17.3	15.8[a]	24.8[a]	30.0	87.9	C
		9/14	Cl + Det.	c	4.30	.43	16.3	16.0	25.8[a]	29.8	87.9	B
		9/21		c	4.18	.42	16.0	18.0	27.1	29.3	90.4	A
		9/14		d	4.38	.41	16.6	16.6	25.8[a]	29.8	88.8	B
Shed-a-leaf	3 lb/A	9/14	Dry	c	4.30	.44	16.8	17.0	26.8[a]	30.0	90.6	B
		9/21		c	-	-	-	-	-	-	-	-
		9/14		d	4.40	.38	16.3	17.3	27.0	30.0	90.6	A
		9/14	Cl	c	4.35	.32	16.5	15.8[a]	26.8[a]	30.0	89.1	C
		9/21			-	-	-	-	-	-	-	-
		9/14		d	4.35	.41	16.5	14.8[a]	26.1[a]	30.0	87.4	C
		9/14	Cl + Det.	c	4.30	.36	16.0	16.5	25.8[a]	29.7	88.0	B
		9/21		c	4.33	.43	17.5	16.2	27.1	29.5	90.3	A
		9/14		d	4.43	.42	15.5[b]	15.7[a]	25.0[a]	29.6	85.8	C

TABLE IV (Continued)

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment[c,d]	pH	Total Acid	U.S.D.A. Grade Factors: Drained Weight	Wholeness	Color	Abs. of Defects	Total Score	Grade
Paraquat	½ pt/A	9/14	Dry	c	4.18	.46	17.6	16.8	26.1[a]	30.0	90.5	B
		9/21		c	4.30	.41	17.0	17.3	26.6[a]	30.0	90.9	B
		9/14		d	4.40	.39	17.1	17.6	28.0	30.0	92.7	A
		9/14	Cl	c	4.25	.38	15.7[b]	15.7[a]	24.2[a]	30.0	85.6	C
		9/21		c	4.30	.42	18.6	15.7[a]	26.1[a]	30.0	90.4	C
		9/14		d	4.30	.43	18.5	16.6	23.5[a]	30.0	88.6	C
		9/14	Cl + Det.	c	4.30	.38	15.8[b]	16.0	26.5[a]	29.3	87.6	B
		9/21		c	4.30	.42	19.3	17.0	26.8[a]	30.0	93.1	B
		9/14		d	4.27	.46	17.5	16.0	26.0[a]	30.0	89.5	B
Control	0	9/14	Dry	c	4.23	.45	18.8	17.1	26.0[a]	30.0	91.9	B
		9/21		c	4.25	.42	16.6	17.5	26.1[a]	29.9	90.1	B
		9/14		d	4.35	.40	16.0	16.6	26.8[a]	29.9	89.3	B
		9/14	Cl	c	4.20	.45	16.2	15.3[a]	25.5[a]	29.9	86.9	C
		9/21		c	4.23	.40	16.6	15.8[a]	26.6[a]	29.9	88.9	C
		9/14		d	4.43	.40	16.0	16.3	26.6[a]	30.0	88.9	B
		9/14	Cl + Det.	c	4.23	.46	17.0	17.0	25.6[a]	29.9	89.5	B
		9/21		c	4.23	.42	16.0	16.2	25.8[a]	29.7	87.7	B
		9/14		d	4.37	.36	16.8	15.0[a]	27.5	30.0	89.3	C

[a] Limiting Rule. Canned tomatoes falling into these classifications may not be graded higher regardless of total score.

[b] Special Limiting Rule. Sample units of canned tomatoes falling into this classification may not be graded higher than U.S. Grade B, regardless of total score.

[c] Steam Peel.

[d] Lye Peel.

TABLE V. GRADE AND OBJECTIVE QUALITY EVALUATIONS OF CANNED TOMATO JUICE

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment (psi)	pH	Total Acid	Vitamin C Mg/100g	Agtron F	% Soluble Solids	Viscosity (Sec)
Shed-a-leaf	4 lb/A	9/14	Comp.*	150	4.5	.40	23.0	38	5.8	49
		9/21	Dry	100	4.47	.42	20.0	37	5.9	61
				150	4.47	.42	21.0	39	5.85	57
			Cl	100	4.47	.41	21.0	36	6.0	55
				150	4.55	.38	22.5	33	5.95	50
			Cl + Det.	100	4.45	.42	22.0	36	5.8	57
				150	4.52	.40	22.0	35	5.68	56
Shed-a-leaf	3 lb/A	9/14	Comp.	150	4.5	.42	25.6	39	5.85	51
		9/21	Dry	100	4.5	.37	18.9	35	5.1	59
				150	4.4	.39	21.0	36	5.5	58
			Cl	100	4.4	.41	21.0	36	5.6	58
				150	4.45	.41	21.0	37	5.5	58
			Cl + Det.	100	4.5	.38	23.5	34	5.9	57
				150	4.5	.42	21.0	35	6.1	54
Paraquat	½ pt/A	9/14	Comp.	150	4.5	.42	23.0	40	6.4	49
		9/21	Dry	100	4.55	.34	21.0	38	5.75	54
				150	4.4	.42	21.0	37	5.8	56
			Cl	100	4.45	.43	32.0	37	5.65	56
				150	4.45	.43	22.0	38	6.0	52
			Cl + Det.	100	4.53	.34	22.5	36	5.65	52
				150	-	-	-	-	-	-

TABLE V (Continued)

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment (psi)	pH	Total Acid	Vitamin C Mg/100g	Agtron F	% Soluble Solids	Viscosity (Sec)
Control	0	9/14	Comp.	150	4.48	.37	24.3	39	5.92	46
		9/21	Dry	100	4.6	.42	21.0	36	5.6	54
				150	4.7	.44	23.0	35	5.9	53
			Cl	100	4.4	.39	21.0	37	5.3	52
				150	-	-	-	-	-	-
			Cl + Det.	100	4.4	.43	22.0	35	5.68	50
				150	4.35	.43	23.1	35	5.75	52

* Composite.

TABLE V (Continued)

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment (psi)	U.S.D.A. Grade Factors					
					Color	Consistency	Abs. of Def.	Flavor	Total Score	Grade
Shed-a-leaf	4 lb/A	9/14	Comp.	150	29	15	15	40	99	A
		9/21	Dry	100	29	15	15	38	97	A
				150	29	15	15	38	97	A
			Cl	100	30	15	15	40	100	A
				150	30	15	15	38	98	A
			Cl + Det.	100	29	15	15	38	97	A
				150	29	15	15	39	98	A
Shed-a-leaf	3 lb/A	9/14	Comp.	150	28	15	15	38	96	A
		9/21	Dry	100	29	15	15	38	97	A
				150	30	15	15	40	100	A
			Cl	100	30	15	15	40	100	A
				150	30	15	15	38	98	A
			Cl + Det.	100	29	15	15	38	97	A
				150	28	15	15	38	96	A
Paraquat	½ pt/A	9/14	Comp.	150	28	15	15	38	96	A
		9/21	Dry	100	27	15	15	37	94	A
				150	28	15	15	38	96	A
			Cl	100	28	15	15	37	95	A
				150	28	15	15	38	96	A
			Cl + Det.	100	29	15	15	39	98	A
				150	-	-	-	-	-	-

TABLE V (Continued)

Defoliant	Rate	Harvest Date	Handling Treatment	Process Treatment (psi)	U.S.D.A. Grade Factors					
					Color	Consistency	Abs. of Def.	Flavor	Total Score	Grade
Control	0	9/14	Comp.	150	27	15	15	37	95	A
			Dry	100	28	15	15	38	96	A
				150	29	15	15	38	97	A
			Cl	100	29	15	15	38	97	A
				150	-	-	-	-	-	-
			Cl + Det.	100	28	15	15	38	96	A
				150	29	15	15	38	97	A

TABLE VI. QUALITY EVALUATION OF POTATOES AND POTATO CHIPS BY DEFOLIANT TREATMENT+ AND STORAGE TEMPERATURES

Defoliant	Rate	Storage Temperature		Specific Gravity	Count	% Yield	Coughlin	Agtron
Control	0	35°		1.067	20.5	24.0	8.5	17.6
		55°		1.065	16.0	24.4	7.5	23.4
		70°		1.066	17.8	27.1	6.2	30.4
			$\bar{x}$	1.066	18.1	25.2	7.4	23.8
Sodium Arsenite	6 lb/A	35°		1.060	21.9	23.7	8.6	14.5
		55°		1.057	22.8	25.5	7.0	22.5
		70°		1.061	23.9	26.6	6.4	24.7
			$\bar{x}$	1.059	22.9	25.3	7.3	20.6
Sodium Arsenite	12 lb/A	35°		1.059	19.0	24.05	8.9	13.5
		55°		1.058	20.1	25.2	7.4	19.5
		70°		1.061	32.0	25.1	7.2	20.5
			$\bar{x}$	1.059	23.7	24.8	7.8	17.8
Paraquat	1 pt/A	35°		1.065	18.5	25.6	8.45	17.0
		55°		1.065	17.3	27.4	6.7	26.3
		70°		1.069	17.5	28.0	6.3	30.3
			$\bar{x}$	1.066	17.8	27.0	7.2	24.5
Paraquat	2 pt/A	35°		1.063	16.0	24.9	8.5	15.1
		55°		1.068	18.0	26.8	6.5	25.4
		70°		1.065	18.0	27.4	6.2	31.2
			$\bar{x}$	1.065	17.3	26.4	7.1	23.9

REMOVAL OF DDT RESIDUES BY UNIT OPERATIONS IN PREPARING AND PROCESSING SPINACH

by

J. R. Geisman, John Deppen and Benita Yao

This report is a summary of research conducted on a federal project with the objective of determining role of unit operations such as washing or blanching in removing insecticide residues. Spinach was chosen as an example of a leafy crop which is extremely difficult to cleanse.

It is possible to obtain two crops of spinach in a single "growing" season. The data reported in the tables are averages obtained from four crops during two seasons 1965 and 1966.

Approximately one month after planting spinach was sprayed with DDT at the recommended rate. Samples were immediately taken to determine the uniformity of application and the reproducability of method used for detection of residues.

Samples were also removed at 5, 10, 15, and 30 day intervals to determine how effectively DDT could be removed prior to the tolerance date.

The processing procedure remained uniform throughout the harvesting periods. The procedure utilized was as follows:

1. Weigh spinach and remove 1 lb. for DDT residue determination.
2. Trim and remove defective portions.
3. Wash for 3 min. in 70° F. water.
4. Divide the samples into two lots.
5. Wash one as in 3 above and wash other as in 3 above with 2500 ppm detergent added.
6. Wash as in 3 above for both lots.
7. Divide both lots into equal portions.
8. One half to be steam blanched for 3 min., the other half to be water blanched (180° F.) for 5 min.
9. After blanching, cool each lot and fill 12 oz. into #303 plain tin cans and cover with hot (180° F.) brine.
10. Close, coding each lot separately, process 20 min. at 250° F. cool and store for analysis.

Samples were removed after each wash and each blanch for DDT residues determinations. Both chromatographic and radiochemical techniques were utilized for residue detection. The results are reported in Table I as

percent reductions calculated on the basis of the residue found at time of harvest. It should be noted that with time the residue was reduced. This relationship was not linear since the residues were as follows:

5 days = 35.0 ppm
10 days = 7.53 ppm
15 days = 1.62 ppm
30 days = 1.41 ppm

TABLE I. PERCENT REDUCTION OF DDT RESIDUE AT 5, 10, 15, AND 30 DAYS AFTER APPLICATION BY UNIT OPERATIONS (AVERAGE FOR 4 CROPS)

Unit Operation	Percent Reduction At			
	5 Days	10 Days	15 Days	30 Days
Plain Wash	46.8	11.4	95.7	50.9
Detergent Wash	74.1	56.3	97.9	82.2
Plain Wash, Hot Water Blanch	73.1	73.3	97.3	74.5
Plain Wash, Steam Blanch	85.8	93.9	97.7	90.8
Detergent Wash, Hot Water Blanch	52.3	56.2	100.0	84.4
Detergent Wash, Steam Blanch	85.3	74.6	94.8	85.2

The results indicated the greatest reduction in residue regardless of treatment was made at 15 days after application. Washing with detergent in most cases greatly increases the removal of the residue. Steam blanching was most effective when used without detergent washing. In most cases, detergent washing was as effective as plain wash combined with hot water blanching. In general, detergent wash followed by steam blanching was most effective in reducing the amount of DDT remaining on the crop.

THE USE OF CHLORINE DIOXIDE IN HANDLING AND HOLDING MECHANICALLY HARVESTED TOMATOES

by

J. R. Geisman, Winston D. Bash, Edwin Schmidt, Jr.
Linda Hamrick and W.A. Gould

The National Canners Association in a report on mechanical harvesting indicated that mechanically harvested fruit may contain more bacterial spores than hand harvested fruit. The use of a bactericidal agent could reduce this spore build-up.

Considerable data have been collected concerning bactericidal agents particularly their effect on quality as well as spore count. During the period 1963 to 1966 data have been collected on two materials: Chlorine as sodium hypochlorite and chlorine dioxide in frozen form and as sodium chlorite powder. The results of these studies indicated that chlorine dioxide was at least two and one half times as effective in controlling spore build-up as chlorine.

With the results obtained, it then becomes a problem of choosing the form of chlorine dioxide to use. There are several distinct advantages of the powder over the frozen form of chlorine dioxide. These are as follows:

1. Ease of storage. There is no need for refrigeration. Powder could be preweighed for field use.

2. Ease of handling. Powder can be handled directly and does not become activated until mixed in water with small amount of hypochlorite or acid.

3. Lack of odor. Frozen form has an obnoxious odor which can cause temporary loss of taste. Powdered form has no odor.

4. Ease of preparation. Powder could be mixed with water prior to use without loss of effectiveness due to breakdown by sunlight.

A use chart could be prepared so that a certain amount of the sodium chlorite could be weighed in the field to be added to each container of tomatoes. Using 500 ppm chlorine dioxide control of spores was maintained after 24 hours .

A comparison of the results between the two forms is presented in Table I.

From Table I it can be seen that chlorine dioxide in the powder form is extremely effective in controlling spores from mechanically harvested tomatoes.

TABLE I. AVERAGE SPORE COUNT OBTAINED USING CHLORINE, DIOXIDE (FROZEN FORM) AND CHLORINE DIOXIDE (POWDER FORM) AFTER 12 AND 24 HOURS

Compound	Form	Concentration (ppm)	Average Spore Count/ml. At 12 Hours	24 Hours
Chlorine	Liquid	1000	400	600
Chlorine Dioxide	Frozen	500	12.5	26.6
Chlorine Dioxide	Powder	500	0	0

EFFECT OF MECHANICAL HARVESTING AND HANDLING OF TOMATOES ON QUALITY OF CANNED TOMATOES

by

Wilbur A. Gould, J. R. Geisman, Edwin Schmidt, Jr.
John McClelland and W. N. Brown

Studies were continued in 1966 similar to the 1965 program with concentration on water handling and holding systems (12 and 48 hours). The basic systems of handling and the detailed data as to each attribute of quality obtained from each treatment are given in Table I. All data were obtained from the variety Heinz 1370 grown at the Ohio Agricultural Research and Development Center, Northwestern Branch, Hoytville. The tomatoes were harvested with a Western Model FMC tomato harvester and handled according to treatments in Table I.

The only treatment with 0 spore count was the lot machine harvested into water with 500 ppm ClO_2. The next best lot in terms of spore counts was the lot hand harvested into hampers. The highest spore counts were obtained with the tanks where Tutane and the tank where detergents were added. The ClO_2 (500 ppm) treatment was more effective than the Cl_2 (500 ppm) lot in control of spore. This is similar to data obtained in 1965. Product quality differences due to treatments were not significantly different. However, it should be pointed out that the water treatment protects the fruit from mechanical damage in filling the containers, in hauling to the factory and in holding prior to processing. Further, fly egg, mold growth and if ClO_2 up to (520 ppm) is added, bacterial spore build-up is also controlled.

TABLE I. EFFECT OF HANDLING TREATMENTS AND HOLDING TIMES ON QUALITY AND GRADE OF CANNED TOMATOES

Treatment	Hold Time in Hours		pH	Total Acid	Drained Weight	Whole-ness	Color	Abs. of Def.	Total Score	Grade	Ave. Spore Count
Hand-Hamper	12		4.32	.365	15**	19.5	25.7*	30	90	B	53.8
	48		4.22	.435	17.3	19.7	27.3	30	94.3	A	83.8
		$\bar{x}$	4.27	.400	16.2	19.5	26.5	30	92.2		68.8
Machine-Hamper	12		4.4	.371	15.3**	19.7	27.3	30	92.3	B	425
	48		4.4	.378	16	17.7	27.3	30	91	A	286.3
		$\bar{x}$	4.4	.375	15.7	18.7	27.3	30	91.7		355.7
Machine-Midwest Lug	12		4.32	.384	15**	19.7	30	29.79	94.3	B	197.5
	48		4.4	.409	16	17.3	26.7*	30	90.7	B	315
		$\bar{x}$	4.36	.397	15.5	18.5	28.4	29.9	92.5		256.3
Machine-California Lug	12		4.4	.378	15.7**	18	27	30	90.3	B	535
	48		4.32	.422	16.7	16.3	26.3*	30	89.3	B	585
		$\bar{x}$	4.36	.400	16.2	17.2	26.7	30	89.8		560
Machine-Plastic Box	12		4.3	.403	15**	19.7	28.3	30	90.7	B	315
	48		4.3	.422	19	18.7	27.3	30	95	A	252.5
		$\bar{x}$	4.3	.413	17	19.2	27.8	30	92.9		283.8
Machine-Tote Box Dry	12		4.4	.378	14.7**	18.7	27.3	30	90.7	B	130
	48		4.3	.275	17	18.3	26*	30	91.3	B	258.8
		$\bar{x}$	4.4	.327	15.9	18.5	26.7	30	91.0		194.4

TABLE I (Continued)

Treatment	Time in Hours		pH	Total Acid	Drained Weight	Whole-ness	Color	Abs. of Def.	Total Score	Grade	Ave. Spore Count
Machine-Tank Dry	12		4.3	.397	15.7**	20	30	30	95.7	B	373.8
	48		4.3	.403	17.3	17.7	27.3	30	92.3	A	265
		$\bar{x}$	4.3	.400	16.5	18.9	28.7	30	94.0		319.4
Machine-Tank	12		4.22	.422	17	18.3	25*	29	89.3	B	0
ClO_2 500 ppm	48		4.32	.371	17.7	17.3	27	30	92	A	0
		$\bar{x}$	4.27	.397	17.4	17.8	26	29.5	90.7		0
Machine-Tank	12		4.30	.371	16	20	26.7*	30	92.7	B	122.5
ClO_2 100 ppm	48		4.4	.371	17	17	24.7*	30	88.7	B	137.5
		$\bar{x}$	4.35	.371	16.5	18.5	25.7	30	90.7		130
Machine-Tank	12		4.3	.39	17.7	16.3	25*	30	89	B	845
ClO_2 500 + Det.	48		4.3	.384	16.7	18.3	26*	30	91.3	B	222.5
		$\bar{x}$	4.3	.387	17.2	17.3	25.5	30	90.2		533.8
Machine-Tank	12		4.3	.416	14.7**	18	26*	30	88.3	B	87.5
ClO_2 50	48		4.28	.39	16.3	18	25.7*	30	90	B	305
		$\bar{x}$	4.29	.403	15.5	18	25.9	30	89.2		196.3
Machine-Tank	12		4.4	.378	16	18.3	25.3*	30	89.7	B	1610
Tutane	48		4.3	.409	16.3	15.3*	25.3	30	87	C	656.3
		$\bar{x}$	4.35	.394	16.2	16.8	25.3	30	88.4		1133.2
Machine-Tank	12		4.4	.358	16.3	17.7	26.3*	30	90.3	B	202.5
Cl_2 500	48		4.39	.365	16.7	17.3	24.7*	30	88.7	B	176.3
		$\bar{x}$	4.40	.362	16.5	17.5	25.5	30	89.5		189.4

* Indicates Limiting Rule.

** Indicates Partial Limiting Rule.